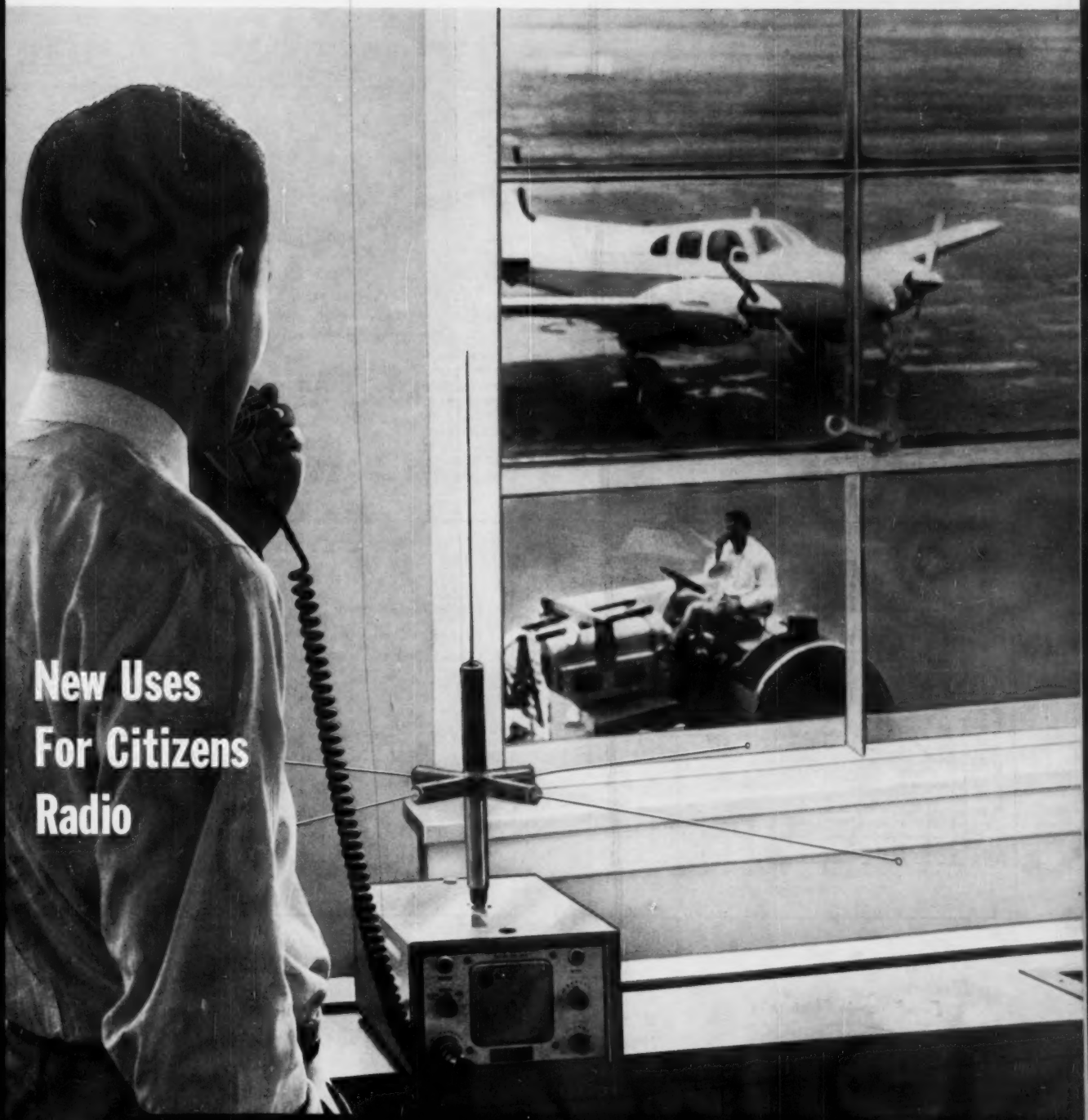
APRIL 10, 1959

electronics

A McGRAW-HILL PUBLICATION VOL. 32, No. 15 PRICE SEVENTY-FIVE CENTS



New Uses For Citizens Radio

Why Missile Control Signals Fail

Creative Microwave Technology

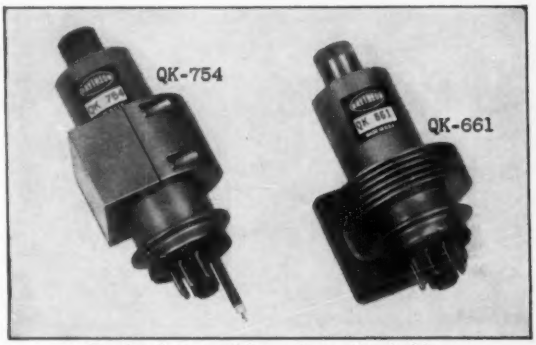
Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON MANUFACTURING COMPANY, WALTHAM 54, MASS., Vol. 1, No. 2

NEW ONE-WATT COMMUNICATION KLYSTRONS COVER GOVERNMENT AND COMMON CARRIER BANDS

Designed primarily for use in microwave relay links, the QK-661 and the QK-754, one-watt transmitter klystrons, operate at frequencies of 7,125 to 8,500 Mc and 5,925 to 6,425 Mc, respectively. The QK-661 is the first tube of its kind to cover the entire government band. The QK-754 is the first of a planned series of tubes to cover the entire communications band.

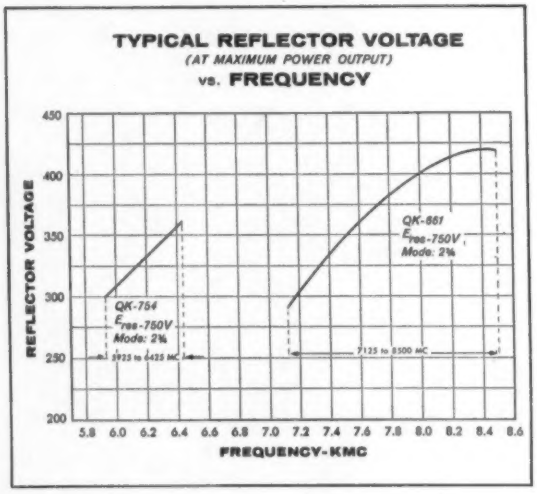
Both are mechanically tuned, integral-cavity, long-life, reflex-type tubes. The QK-754 uses a coaxial output; the QK-661, a waveguide output.

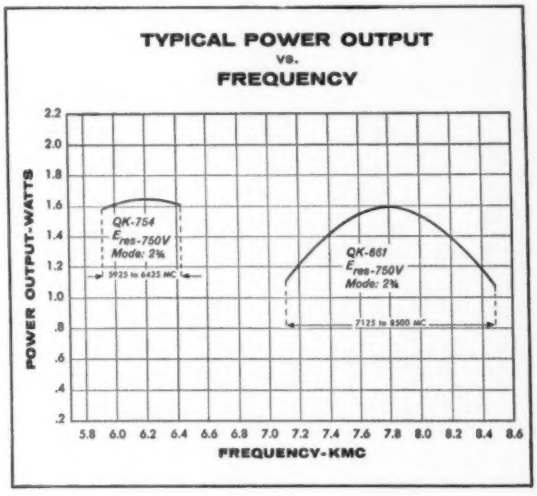
To insure efficient operation the tubes are available with integral cooling fins or with a heat-sink attachment suitable for connection to the chassis.



Typical operating characteristics

	QK-754	QK-661
Frequency Range	5925 to 6425 Mc	7125 to 8500 Mc
Power Output	1.5 watts	1.6 watts
Electronic Tuning (to half-power pts)	50 Mc	25 Mc
Modulation Sensitivity (10 V pk-to-pk mod volt)	1 Mc/V	600 Kc/V
Temp. Coefficient	± 0.1 Mc/°C	± 0.1 Mc/°C





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APRIL 10, 1959

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Vol. 32 No. 15

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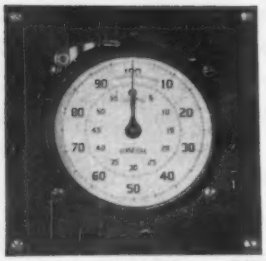
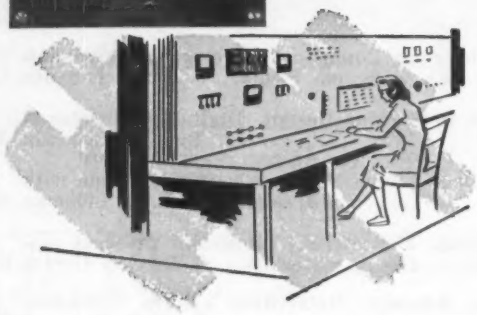
STANDARD ...SYNONYM for PRECISION in TIMING





For timing requirements in research, testing or production . . . if the need for *precision* is paramount . . . the choice is STANDARD.

Recognized as THE criterion by which other timers are judged (and *calibrated*), STANDARD Elapsed Time Indicators are noted for their long life under continuous use.

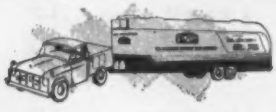
Large enough to work with handily and read readily, STANDARD timers are electric clutch controlled by manual or automatic switch or by electric circuits or output of electronic tubes. Units are synchronous motor driven . . . available for flush panel mounting or portable use . . . equipped for manual or electric zero reset.

For ultra precision timing with AC current, models available for 400 CPS operation. Also available: 400 CPS power supply operating from DC source.

MODEL	SCALE DIVISIONS	TOTALIZES	ACCURACY
S-100	1/5 sec.	6000 sec.	±.1 sec.
S-60	1/5 sec.	60 min.	±.1 sec.
SM-60	1/100 min.	60 min.	±.002 min.
S-10	1/10 sec.	1000 sec.	±.02 sec.
S-6	1/1000 min.	10 min.	±.0002 min.
S-1	1/100 sec.	60 sec.	±.01 sec.
MST	1/1000 sec.	.360 sec.	±.001 sec.
MST-500	1/1000 sec.	30 sec.	±.002 sec.

Request descriptive Catalog No. 198

THE STANDARD ELECTRIC TIME COMPANY | **89 LOGAN STREET SPRINGFIELD, MASSACHUSETTS**



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This unprecedented five-year guarantee is the strongest proof of consistent trouble-free power supply performance ever offered. It is bolstered even further by a series of independent surveys which prove that Lambda equipment is preferred by more than 50% of the engineers who specify power supplies.

CHECK LIST: LAMBDA REGULATED DC POWER SUPPLIES

Model	Style	Voltage Range (VDC)	Current Range (MA DC)	Regulation Impedance Ripple (Table I)	6.3 VAC Output (Amps)	Meters	Output Voltage Control	Output Terminals	Size Weight (Table II)	Price (U.S. and Canada) F.O.B. Factory College Pt., N. Y.
REGULATED POWER SUPPLIES — RACK MOUNTING										
TRANSISTORIZED										
LT-1095	Rack	0-32	0-1000	A	—	None	Rear	Rear	S-1	285.00
LT-1095M	Rack	0-32	0-1000	A	—	2½" rect	Rear	Rear	S-1	315.00
LT-2095	Rack	0-32	0-2000	B	—	None	Rear	Rear	S-1	365.00
LT-2095M	Rack	0-32	0-2000	B	—	2½" rect	Rear	Rear	S-1	395.00
TUBE REGULATED										
C-280	Rack	0-200	0-200	C	10A	None	Rear	Rear	S-2	184.50
C-280M	Rack	0-200	0-200	C	10A	3½" rect	Rear	Rear	S-2	214.50
C-281	Rack	125-325	0-200	C	10A	None	Rear	Rear	S-2	159.50
C-281M	Rack	125-325	0-200	C	10A	3½" rect	Rear	Rear	S-2	189.50
C-282	Rack	325-525	0-200	C	10A	None	Rear	Rear	S-2	169.50
C-282M	Rack	325-525	0-200	C	10A	3½" rect	Rear	Rear	S-2	199.50
C-480	Rack	0-200	0-400	D	15A	None	Rear	Rear	S-2	259.50
C-480M	Rack	0-200	0-400	D	15A	3½" rect	Rear	Rear	S-2	289.50
C-481	Rack	125-325	0-400	D	15A	None	Rear	Rear	S-2	244.50
C-481M	Rack	125-325	0-400	D	15A	3½" rect	Rear	Rear	S-2	274.50
C-482	Rack	325-525	0-400	D	15A	None	Rear	Rear	S-2	259.50
C-482M	Rack	325-525	0-400	D	15A	3½" rect	Rear	Rear	S-2	289.50
C-880	Rack	0-200	0-800	E	20A	None	Rear	Rear	S-3	340.00
C-880M	Rack	0-200	0-800	E	20A	3½" rect	Rear	Rear	S-3	370.00
C-881	Rack	125-325	0-800	E	20A	None	Rear	Rear	S-3	315.00
C-881M	Rack	125-325	0-800	E	20A	3½" rect	Rear	Rear	S-3	345.00
C-882	Rack	325-525	0-800	E	20A	None	Rear	Rear	S-3	360.00
C-882M	Rack	325-525	0-800	E	20A	3½" rect	Rear	Rear	S-3	390.00
C-1560	Rack	0-200	0-1500	F	30A	None	Rear	Rear	S-4	550.00
C-1560M	Rack	0-200	0-1500	F	30A	3½" rect	Rear	Rear	S-4	580.00
C-1561	Rack	125-325	0-1500	F	30A	None	Rear	Rear	S-4	575.00
C-1561M	Rack	125-325	0-1500	F	30A	3½" rect	Rear	Rear	S-4	605.00
C-1562	Rack	325-525	0-1500	F	30A	None	Rear	Rear	S-4	550.00
C-1562M	Rack	325-525	0-1500	F	30A	3½" rect	Rear	Rear	S-4	580.00
28	Rack	200-325	0-100	G	3A	None	Rear	Rear	S-5	59.50
28M	Rack	200-325	0-100	G	3A	3½" rect	Rear	Rear	S-5	89.50
29	Rack	100-200	0-100	H	3A	None	Rear	Rear	S-5	69.50
29M	Rack	100-200	0-100	H	3A	3½" rect	Rear	Rear	S-5	99.50
32	Rack	200-325	0-300	J	2 @ 5A	None	Rear	Rear	S-6	138.50
32M	Rack	200-325	0-300	J	2 @ 5A	3½" rect	Rear	Rear	S-6	168.50
33	Rack	100-200	0-300	J	2 @ 5A	None	Rear	Rear	S-6	154.50
33M	Rack	100-200	0-300	J	2 @ 5A	3½" rect	Rear	Rear	S-6	184.50
50R	Rack	0-500	0-500	K	2 @ 5A	4½" rect	Front	Fr & rear	S-7	420.00
		0-50	Bias	L						
		0-200	High imped.	M						
REGULATED POWER SUPPLIES — PORTABLE AND BENCH										
25	Bench	200-325	0-100	G	3A	None	Front	Front	S-8	80.50
26	Bench	100-200	0-100	H	3A	None	Front	Front	S-8	79.50
50	Bench					See Model 50R above			S-9	440.00
71	Portable	0-500	0-200	N	2 @ 5A	3½" rect	Front	Front	S-10	310.00
		0-50	Bias	P						
		0-200	High Imped.	Q						

TABLE I
DC OUTPUT VOLTAGE REGULATION, IMPEDANCE, RIPPLE

	Regulation Line (105-125 VAC)	Regulation Load (min to max)	Internal Impedance (ohms)	Ripple, rms (millivolts or %)
	Less than	Less than	Less than	Less than
A	0.15% or 20MV	0.15% or 20MV	0.50	1 mv
B	0.15% or 20MV	0.15% or 20MV	0.025	1 mv
C	0.15% or 0.3V	0.25% or 0.5V	6	3 mv
D	0.15% or 0.3V	0.25% or 0.5V	3	3 mv
E	0.15% or 0.3V	0.25% or 0.5V	1.5	3 mv
F	0.15% or 0.3V	0.25% or 0.5V	0.75	3 mv
G	1%	1%	10	10 mv
H	1%	1%	10	5 mv
J	1%	1%	4	10 mv
K	0.15% or 0.1V	0.5% or 0.3V	2	8 mv
L	0.1%	unregulated	3,300	2 mv
M	0.1%	unregulated	17,500	5 mv
N	0.15% or 0.3V	0.15% or 0.3V	4	5 mv
P	0.1%	unregulated	5,500	2 mv
Q	0.1%	unregulated	25,000	5 mv

TABLE II
SIZES AND WEIGHTS

	Size H x W x D (Inches)	Weight Net (lbs)	Weight Shipping (lbs)
S-1	3½ x 19 x 14⅛	35	65
S-2	5¼ x 19 x 14⅛	53	80
S-3	7 x 19 x 14⅛	84	100
S-4	8¾ x 19 x 14⅛	120	140
S-5	5¼ x 19 x 8	19	23
S-6	10½ x 19 x 9¼	42	52
S-7	10½ x 19 x 14⅛	80	140
S-8	8 x 14 x 8	19	23
S-9	12½ x 22 x 15	110	150
S-10	13 x 8¾ x 14½	49	65

GENERAL SPECIFICATIONS

Sufficient tolerance is incorporated in the specifications to allow for normal commercial component and tube deviations. Tube replacements may be made with any equivalent tubes meeting E.I.A. specifications.

INPUT 105-125 VAC, 50-400 CPS, single phase. Exceptions: Models 50, 50R and 71 — 105-125 VAC, 50-60 CPS.

DC OUTPUT *Voltage Range:* Continuously variable over ranges specified, except where otherwise noted.
Current Range: The current ranges given apply to the entire DC output voltage range, and for input voltages from 105 to 125 VAC. No "de-rating" is necessary.
Polarity: Either positive or negative terminal may be grounded.

AC OUTPUT The AC output is unregulated, isolated and ungrounded. It has a value of slightly higher than 6.3 V (when fully loaded) at an input of 115 VAC. This value allows for voltage drop in connecting leads. Dual outputs may be connected in series or parallel.

DUTY CYCLE Continuous duty at full load.

METERS Where meters are indicated, a separate voltmeter and milliammeter are provided.

OVERLOAD PROTECTION Ample protection is provided against external overload and internal failure conditions by means of fuses.
Circuit breakers of the magnetic, "trip-free" type are employed in Models 50, 50R, 71 and LT series as protection against external overloads. And in the LT series, the transistor complement is independently protected by special transistor circuitry.

STYLE Rack Models are designed for mounting on standard 19" relay racks.

Bench Models are provided with compact, specially-designed, ventilated cabinets equipped with carrying handles. The power supply units may be removed from their cabinets for mounting in standard relay racks (except Models 25, 26 and 71).

RATINGS AND COMPONENTS All components used are of the highest quality and are operated well within manufacturers' ratings. Hermetically-sealed, oil-filled capacitors are used exclusively, except in LT series, where special high purity foil, long-life electrolytics are used. "C" and "LT" series power supplies use hermetically-sealed magnetic components exclusively. Ample safety factors are provided in the design to insure the long life, and the dependable, trouble-free operation so desirable in industrial and laboratory applications.

All specifications and prices subject to change without notice.

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April 10, 1959 Vol. 32, No. 15

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SHOPTALK . . .

SPACE COMMUNICATIONS. Talking to satellites and space ships will entail solving propagation problems that are literally out of this world.

Under sponsorship of the Air Force Cambridge Research Center, field stations all over the U. S., in Alaska, Greenland, Norway and Sweden, have been studying how signals from radio stars are bent, absorbed and otherwise abused as they penetrate the various layers of the earth's atmosphere. The Air Force's reason for settling in Eskimosville is that atmospheric and ionospheric propagation effects are most pronounced in the auroral zone.

Getting this first complete story on what's new under the midnight sun took New England Editor Maguire to project headquarters at Cambridge Research Center and to field stations in the Boston area. For Maguire's complete report on this wide ranging project, together with a rundown on a few new facts on interplanetary communication, see p 32.

TRENDS AND TALKS. Broadcasters from all over the U. S. had their say on a number of important issues at the recently concluded Chicago convention of the National Association of Broadcasters.

On hand to hear them was Electronics' Midwestern Editor, Hap Harris. Among the important developments he reports is the implementation of last year's FCC ruling allowing private microwave hookups by broadcast stations. A growth in station automation is also noted. For news on this and other trends, see p 47.

Coming In Our April 17 Issue . . .

SOLID-STATE PROGRESS. One of the most dynamic areas of our industry is in solid-state technology. Vast changes in circuits and circuit elements are augured by today's basic research into the properties of semiconductors and other materials. Already, many new devices and applications are in modern electronic systems.

Next week, Associate Editor Weber brings you up to date on some of the newest contributions of the solid-state treasure house. You'll learn how parametric amplifiers are proving their worth in the field, how a new microwave power source may revolutionize satellite communications, how computers are being shrunk by the use of new cryotron elements and thin films. You'll get details on the new solid-state version of the stepping tube and the versatile field effect current limiter.

MISSILE SCORING. In missile testing, since inert warheads are usually used, a method to indicate the closest approach of a missile to the target must be provided. A miss-distance-indicator system that uses neither pulsed nor doppler radar techniques is described by J. A. Adams of the Ralph M. Parsons Co., in Los Angeles.

The system consists of target and missile transponders, a recording ground station and high-gain directive antennas. Two uhf carrier frequencies carrying distance information in the form of pfm are used in the link between transponders.

IMPROVED DIRECTION FINDER. The effectiveness of direction-finders used in the 1.5 to 30-mc band for navigation has always been limited by multi-path propagation in the ionosphere, which causes rapid changes in indicated bearings.

According to J. F. Hatch and D. W. G. Byatt of Marconi Wireless and Telegraph Co., of England, accuracy can be greatly improved by averaging a number of readings over a period of time. Their article describes a system which performs this function automatically.

SPRAGUE® RELIABILITY
in these two dependable wirewound resistors

MINIATURE

Blue Jacket®

VITREOUS-ENAMEL POWER RESISTORS

Sprague's new improved construction gives even greater reliability and higher wattage ratings to famous Blue Jacket miniature axial lead resistors.

A look at the small *actual sizes* illustrated, emphasizes how ideal they are for use in miniature electronic equipment with either conventional wiring or printed wiring boards.

Get complete data on these dependable minified resistors, **write for Engineering Bulletin 7410.**

TAB-TYPE BLUE JACKETS: For industrial applications, a wide selection of wattage ratings from 5 to 218 watts are available in Sprague's famous Tab-Type Blue Jacket close-tolerance, power-type wirewound resistors. Ideal for use in radio transmitters, electronic and industrial equipment, etc. **For complete data, send for Engineering Bulletin 7400A.**

NEW SMALLER SIZE

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INSULATED-SHELL POWER RESISTORS

New Koolohm construction features include welded leads and winding terminations—Ceron ceramic-insulated resistance wire, wound on special ceramic core—multi-layer non-inductive windings or high resistance value conventional windings—sealed, insulated, non-porous ceramic outer shells—*aged-on-load* to stabilize resistance value.

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Send for Engineering Bulletin 7300 for complete technical data.

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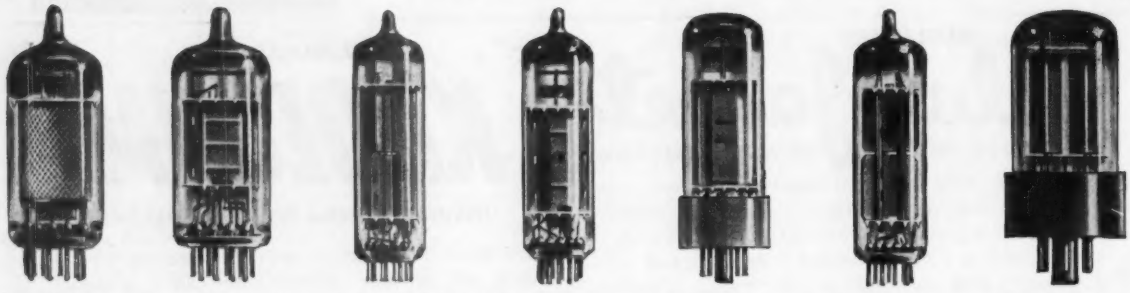
ELECTRONICS IN BRITAIN

SEVEN TUBES FOR STEREO



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High gain AF input pentode with exceptionally low noise, low hum and low microphony.

ECC83 12AX7
Double triode, low hum, low microphony, low noise, high gain tube.

ECL82 6BM8
Miniature triode pentode for use as audio amplifier and output tube. Two tubes in ultralinear push-pull can supply up to 7 watts of stereo power per channel.

EL84 6BQ5
Miniature 12 watt high slope pentode. A medium power high fidelity tube particularly suitable for compact stereo circuits, up to 17 watts per channel.

EL34 6CA7
Highly sensitive 25 watt pentode. Two tubes in ultralinear push-pull providing up to 34 watts output, particularly suited for compact integrated stereo amplifiers.

EZ81 6CA4
Miniature full wave cathode type rectifier with high voltage and with good regulation supplying up to 150mA.

GZ34 5AR4
Bantal full wave cathode type rectifier, supplying high voltage with good regulation and with currents up to 250mA.

Supplies available from:

In the U.S.A.
International Electronics Corporation
81 Spring Street, N.Y.12, New York, U.S.A. *Worth 6-0790.*

In Canada
Rogers Electronic Tubes & Components
116 Vanderhoof Avenue, Toronto 17, Ontario, Canada. *Hudson 5-8621.*

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ELECTRONIC TUBES used throughout the world

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IF YOU DON'T MIND THE SCORE*

VITREOUS ENAMEL POWER RESISTORS MAY DO

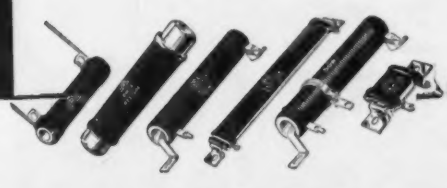
The Temperature Coefficient of power wire wound resistors is a lot like golf. The higher the "score" the worse the performance. Even on special order, vitreous enamel coated PWW's are not guaranteed for a temperature coefficient of less than ±80 p.p.m. (and they often run up duffer scores) whereas IRC Resisteg Coated Power Wire Resistors consistently average ±25 p.p.m.

The reason is simple. Vitreous enamel units are cured at temperatures of 1200°F or over. At this temperature the turns of wire tend to loosen, shift and even short. Finer wire is therefore used to achieve wider spacing and turns are tension wound. The end result is a high temperature coefficient, and a substantial resistance change for any change in temperature.

On the other hand, IRC Resisteg Coated Resistors are cured at only 205°F *or less*, can be wound with a larger diameter wire, more closely spaced, and without extra tension. The Temperature Coefficient is about ±25 p.p.m. after the cure or only slightly higher than that of the original wire. So why work with the high handicap resistor coating? Insist on IRC Resisteg Coated PWW's.

* **Vitreous Enamel Power Resistors best guaranteed score is at least ±80 p.p.m. for Temperature Coefficient and then only on special order. But the par for IRC Resisteg Coated Resistors is only ±25 p.p.m.**

Write for new Power Wire Wound Resistor Bulletin C-1C.



Wherever the Circuit Says

IRC

INTERNATIONAL RESISTANCE COMPANY, Dept. 375, 401 N. Broad Street, Philadelphia 8, Pa.

COMPUTER RESEARCH: Though computers cannot yet approach the memory capacity and versatility of the human brain as an information processing device, Lockheed research scientists are engaged in building artificial neurons patterned closely after those of the brain. Neurons are connected in large networks and their behavior pattern observed. Information obtained through this research is being used in the solution of elementary problems in learning and pattern recognition. Progress in this field is symbolized by the abacus – earliest form of computer.

COMPUTER RESEARCH

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

Lockheed's activities in the missile field began before World War II when the company designed and flew a pilotless aircraft for the Army Air Corps. Today the Missiles and Space Division embraces every facet of research and development, engineering, test, and manufacture. It has complete capability in more than 40 areas of science and technology, from concept to operation.

The Division's advanced research and development programs now under intensive study provide a fascinating challenge to creative engineering. These programs include: man in space; space communications; electronics; ionic, nuclear and solar propulsion; magnetohydrodynamics; oceanography; computer research and development; operations research and analysis; human engineering; electromagnetic wave propagation and radiation; materials and processes and others.

Such programs reach far into the future and deal with unknown environments. It is a rewarding future which scientists and engineers of outstanding talent and inquiring mind are invited to share. Write: Research and Development Staff, Dept. D-22, 962 W. El Camino Real, Sunnyvale, California.

"The organization that contributed most in the past year to the advancement of the art of missiles and astronautics."

NATIONAL MISSILE INDUSTRY CONFERENCE AWARD

Lockheed / **MISSILES AND SPACE DIVISION**

Weapons Systems Manager for the Navy POLARIS FBM; DISCOVERER SATELLITE; Army KINGFISHER; and Air Force Q-5 and X-7

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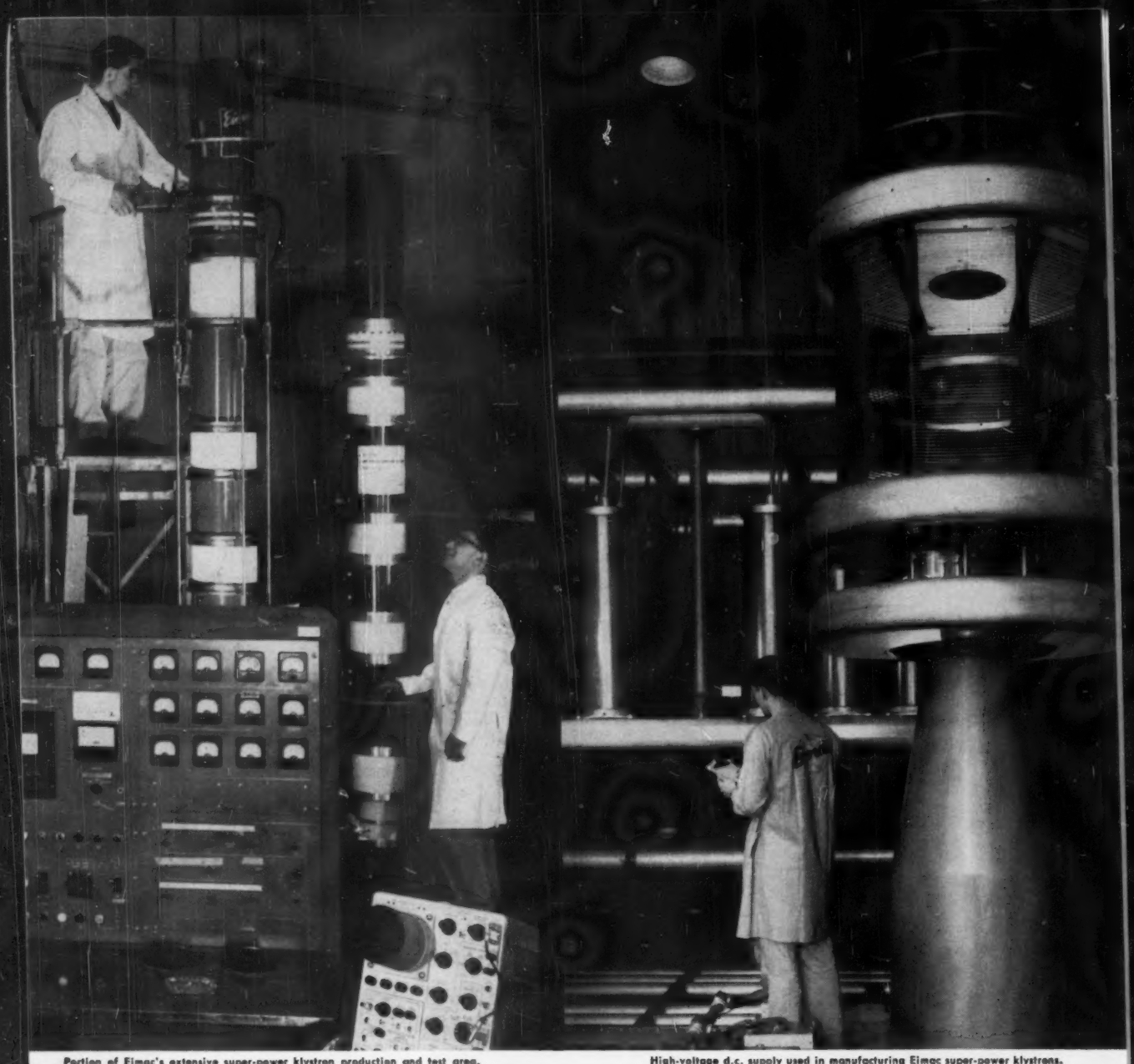


Portion of Eimac's extensive super-power klystron production and test area.

High-voltage d.c. supply used in manufacturing Eimac super-power klystrons.

SUPER-POWER UHF KLYSTRONS FOR SPACE RADAR NOW IN FULL PRODUCTION AT EIMAC

Tracking fast-moving ballistic missiles and satellites at great distances requires exceptionally powerful radar equipment. Eimac super-power amplifier klystrons, capable of one and one-quarter megawatt peak power and 75 kw average power at ultra-high frequencies, have made these new "space radars" possible. Development of these klystrons, the world's largest electron tubes, has been completed at Eimac and full power tubes have been delivered. They are now being manufactured in production quantities. In addition to radar, Eimac super-power klystrons can be used in linear accelerator and high-power tropo-scatter applications.

Production of these tubes is being carried on at the Eimac High-Voltage Laboratory in San Bruno, California, where development work was done. Complete facilities are available there for the fabrication, assembly, pumping and testing of these giant tubes. Two power supplies, each capable of producing 120,000 volts d.c. at two and four amperes are used in production and testing operations.

This success in developing and placcing these tubes in full production in a relatively short time is indicative of Eimac's extensive experience in the field of high-power UHF electron devices. Other Eimac amplifier klystron types are used widely in military and commercial tropo-scatter networks throughout the world.

For high power at ultra-high frequencies investigate the many advantages of Eimac external-cavity amplifier klystrons.

EITEL-McCULLOUGH, INC.

Eimac

San Carlos • California

CIRCLE 8 READERS SERVICE CARD

ELECTRONICS NEWSLETTER

SILICON LOGIC ELEMENT measuring only 0.000016 cu in. has been developed by RCA using the concept of integrated (molecular) electronics. Numbers of such elements could be assembled in various arrays to perform all of the functions of present conventional logic elements without separate components, says the firm. RCA says printed circuits, alternated with silicon layers sandwich-style, could be used to make connections. Development of integrated devices, says the firm, may mean component densities in the next few years of 100 million per cu ft. Next step could be computer circuits of a million components inside a 4-in. sphere. Research may also lead to use of gallium arsenide, indium phosphide and other materials that perform efficiently at high temperatures.

Automatic Checkout and Readiness Equipment (ACRE) is being developed by Lockheed for Polaris submarines with functions of day and night monitoring, testing, and operational verification in go/no-go form.

IMAGE ORTHICON TUBE which picks up low-light-level in operating conditions ranging from full sunlight to pitch darkness is being used experimentally by the Army and Navy. GE, the developer, has just received two Army R&D orders totaling $154,365. One order is for development of the tv camera tube for use in tank night-fire-control equipment, the second for a year's study to develop more sensitive thin-film targets for the tube. GE says key to experimental tube's operation is a specially designed high-gain target only millionths of an inch thick.

Russian scientists say they have produced aluminum 99.99999 pure for use in the electronics industry. A plant is being built for production of the ultrapure aluminum in quantity.

FIRST COMMERCIAL NUCLEAR power plant in France will be controlled by data from two production-type digital computers rather than custom-built analog computers when it goes into full operation next fall. Two RW-300 digital control computers of The Thompson-Ramo-Wooldridge Products Co. are being used in the reactor's instrumentation by prime contractor Intertechnique, a subsidiary of the Dassault aircraft company. System will monitor the radioactivity of the carbon dioxide cooling gas flowing through 1,148 channels in the reactor; it scans binary counters connected to radiation detectors, then calculates radioactivity value for each channel, compares it with a safe limit and actuates an alarm if necessary. It will also print out data on six typewriters.

MOSCOW OFFICE to study Soviet scientific developments of possible commercial value in the U. S. has just been opened by Rand Development Corp. President H. James Rand and other company representatives reached an agreement with the Soviet government after talks with top economic and scientific people. Among Soviet developments of interest to Rand: a refrigerator using semiconductor elements and no moving parts; a translation and reading machine whose internal storage is said to be capable of holding all half million documents appearing in the world's scientific literature each year. The computer will take up a five-story building when completed, probably this year, says Rand.

MAGNETIC TAPE PERFORMANCE in recording data transmitted by missiles and satellites is being studied by the National Bureau of Standards with a view towards formulating standardization tests to permit quality control. NBS is developing a method of magnetic testing which allows evaluation of tape without reference to a recorder.

JET-AGE PROBLEMS will dominate 11 meetings to be held during the World Congress of Flight, next week in Las Vegas, Nev. Present and future uses of c-w Doppler systems, inertial guidance and hyperbolic systems will be discussed. Concepts of air traffic control through the year 2,000 will be considered. More than 100,000 sq ft of exhibits featuring new gear will be shown.

SPARROW III follow-on production contract totaling $64.6 million, which was recently awarded to Raytheon, will mean subcontracts totaling about $38 million to more than 550 direct subcontractors, says the firm.

Regular use of masers and parametric amplifiers for communicating with space probes is a certainty in the near future. NASA says that by 1960 it must be able to maintain communications up to 40 million miles; it aims for "hundreds of millions of miles as soon thereafter as possible."

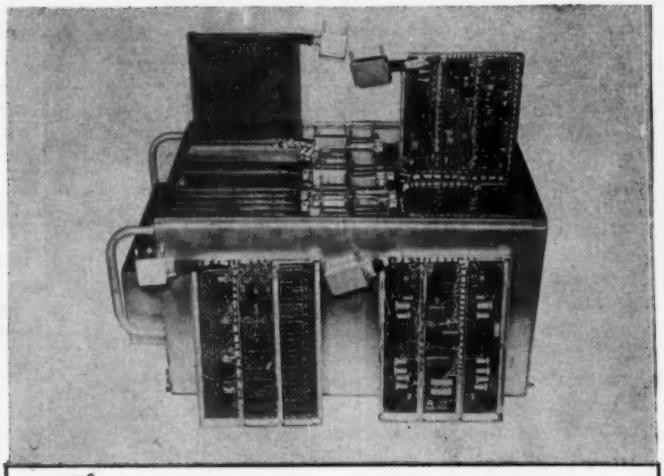
ULTRASONICS may be combined with conventional welding methods to improve the joining of metals, once control problems are overcome. Experiments by Battelle Memorial Institute indicate ultrasonic vibration would be useful in resistance welding, brazing, and especially arc welding. Reduction of surface tension of molten metals permits closer contact between metals; gas bubbles are driven out and crystal structures that make a weld brittle are inhibited. Removal of oxides and surface contaminants, says Battelle, also aids closer metal contact.

INSO Fused-Film Teflon® Insulated Wire meets all the rigid require-ments of LFE's Doppler Airborne Navigation System!

Seldom have wire specifications been so rigid and the tolerance so small. LFE subjected INSO fused film Teflon insulated wire to exhaustive tests and found that it measured up — in all respects — to their strict requirements.

INSO's success is no accident. Our precision-fusing process insures constant quality wire and allows you to enjoy the full potential of miraculous Teflon insulation. The problems that plague other wires just aren't present. INSO gives you as much as 100% space advantage and 35% weight saving. The insulation is perfectly concentric and the wire dresses easily, holding any position, any form.

Most important, INSO is available in economical continuous lengths without breaks or splices *and without any pinholes*. This minimizes rejects and reduces wire failures to a minimum.



The Laboratory for Electronics Doppler Airborne Navigation System, adaptable to both supersonic jet aircraft and helicopters.

Weighing only 210 lbs. and occupying less than 7 cubic feet, the Doppler automatically supplies pilots with continual present position coordinates, ground speed, track, course and distance to target, wind vector components, wind "memory," and alternate destination selection.

Inso Type 6E22-B wire is used throughout the entire computer and Inso Type 8EE20-B and 8EE22 is used for the power supply.

If you have a really tough wire problem, consult with our engineering staff. You'll find that "no-problem" INSO wire and cable meet the requirements better than any other product now available. For information, samples and technical data, write, wire or call us today.

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CLARE Lowers Prices

Type HG

Type HGP

Type HGS

Type HG2

Type HG4

on all Mercury-wetted contact relays

Reductions range from 7½% to 10%

When prices for just about everything are continuing to rise, and all thinking men are concerned over the danger of inflation, it is important news when a manufacturer makes a significant price reduction.

Increased production resulting from the wide acceptance of Clare Mercury-Wetted Contact Relays, together with improvements in skill and in manufacturing equipment and methods, make it possible for Clare to reduce prices for these superior relays in spite of rising labor and material costs.

A price reduction ranging from 7½% to 10% will be applied to all orders placed after March 31, 1959, for Clare Mercury-Wetted Contact Relays—Types HG, HGP and HGS. The reduction will also affect multi-element relays such as HG2, HG3, HG4, etc.

These lower prices for relays whose life is measured in *billions of maintenance-free operations* will be exciting news to all designers of continuous-duty, high-speed switching devices and systems.

Write or Wire: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable Address: CLARELAY.

CLARE RELAYS

FIRST in the industrial field

.01 db precision for 20 db measurement with changes of .1 db in level of r. f. source

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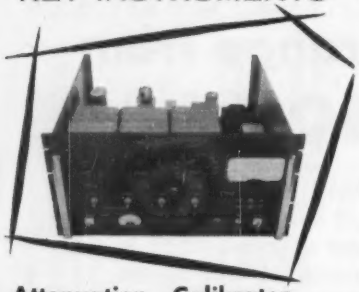
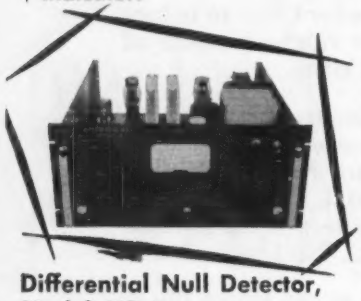
dual channel
INSERTION LOSS
TEST SET

Systems Accuracy .02 db/10 db
20 db attenuation range, direct.
40 db range with partial r.f. substitution. Frequency Range:
20 MCS to 90,000 MCS
KEY INSTRUMENTS



Attenuation Calibrator, Model BA-5
Combines Precise Audio Substitution Attenuator, Bolometer Preamplifier and Level Indicator.



Differential Null Detector, Model ND-1
Specifically designed for two channel loss measurements.

For theory, method, required instruments and recommended accessories, request Application Notes #4.

Weinschel Fixed Coaxial Attenuators cover the frequency range of DC to 12 KMC. Write for complete catalog, specifying frequency range of interest.

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Weinschel Engineering
KENSINGTON, MARYLAND

CIRCLE 11 READERS SERVICE CARD

WASHINGTON OUTLOOK

HOUSE APPROPRIATIONS COMMITTEE investigators have made a full-scale study of reliability efforts in ballistic missile projects. Major conclusions: industry has not produced sufficiently durable and reliable units; there is inadequate testing of units in advance of final assembly; and military inspectors and inspection techniques have not kept pace with the complexities of modern weapons.

The committee proposes that reliability requirements be written into military specs. The Pentagon is also urged to place more emphasis on simultaneous environmental testing and simulated flight testing of units.

● **The Navy is pushing** a new program to improve tactical communications between shore installations and air, surface and underwater forces. Objective is to increase the range and reliability of radio voice communications and allow teletypewriter communications between commanders. Single-sideband gear is being introduced.

Right now, the stress is on line-of-sight ship-to-air and air-to-air communications. Major reliance is on double-sideband equipment in the ultrahigh frequency range. Here the Navy plans to boost power and incorporate rapid frequency-shifting features.

Navy is also evaluating an optical short-range tactical communications system. This will involve flashing light and provide multichannel voice, teletypewriter or facsimile capabilities.

Also in the works is a plan to upgrade shore-to-fleet communications—increasing the reliable range, transmission speed and traffic capacity. New equipment for this shore-to-ship linkage will be installed on submarines and selected surface vessels.

To improve radio reception capabilities of completely submerged subs, construction of a very low frequency transmitting station in Maine is being stepped up, while construction of a companion transmitter in Guam is planned.

In shore communication networks, point-to-point circuits are being converted to single-sideband equipment with as many as 16 channels. Sometime this year the Navy will also start operating a Washington-Pearl Harbor circuit using the moon as a passive relay. This will provide great reliability and be immune to jamming.

Special R&D emphasis is being placed on two-way communications between submerged subs. The Navy considers as promising long-range underwater communications in the audio-frequency band.

● **Even though** the Air Force's fiscal 1960 budget provides funds for procurement of 40 more of Convair's electronics-laden, Mach 2 medium-range B-58 bomber, Pentagon insiders say the project is vulnerable to new production cutbacks. Sixty-six planes are now on order or have been delivered. Some officials are backing a plan to convert the plane into a long-range interceptor aircraft armed with air-to-air missiles.

The project was almost scuttled last fall when the new budget was put together. Although the project has survived, there are some influential Washington officials—either eager-beaver budget-cutters or backers of rival projects seeking more funds—still gunning for the B-58.

In top-level Pentagon councils arguments are still heard that the project should be trimmed or eliminated. The claims: the plane has only a "limited stand-off missile capability" and would require "reconfiguration" to handle presently planned air-to-surface missiles; that the plane's chief virtue is high speed over target—a bomber capability no longer considered as vital as before.

Now from **CLEVITE ...**

HIGH POWER TRANSISTORS

Clevite offers new types with improved reliability and power handling capacity.

EIA REGISTERED TYPES WITH:

- **Improved seal for long life.**
- **Saturation voltage less than 1 Volt at increased maximum rated current of 15 amperes.**
- **Average thermal resistance 0.7°C per watt.**
- **Current gain controls: 60-150 at 5 amperes.**
- **100% test for resistance to transient burn out.**
- **Either standard pins or solder lugs.**

TECHNICAL DATA

Typical Electrical Characteristics at 25°C

2N1147 Series has solder lugs 2N1146 Series has standard pins	2N1147 2N1146	2N1147A 2N1146A	2N1147B 2N1146B	2N1147C 2N1146C
Collector to Emitter Voltage Shorted Base (IC = 1 amp)	30V (Min)	40V (Min)	60V (Min)	75V (Min)
Saturation Voltage (IC = 15 amps)	1.0V (Max)	1.0V (Max)	1.0V (Max)	1.0V (Max)
DC Current Gain (IC = 5 amps)	60-150	60-150	60-150	60-150
DC Current Gain (IC = 15 amps)	35	35	35	35
Absolute Maximum Ratings				
Collector Current	15 amps	15 amps	15 amps	15 amps
Collector to Base Voltage	40V	60V	80V	100V
Collector to Emitter Voltage	40V	60V	80V	100V
Power Dissipation at 70°C Case Temperature	25W	25W	25W	25W
Junction Temperature	95°C	95°C	95°C	95°C

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Tensolite RELIABLE HIGH TEMPERATURE WIRE & CABLE

Tensolite facilities are devoted exclusively to the engineering and manufacturing of miniature plastic insulated wire and cable—featuring Teflon insulation for high temperature (—90 deg. C. to +250 deg. C.) applications. 100 percent inspections before, during and after manufacture, part of the most rigid quality control program in the industry, assures reliability of the finished product.

"TEFLON" INSULATED CABLE

From large sizes using 6 AWG wire down to subminiature cables with 36 AWG single conductors, Tensolite makes multi-conductor cables to your specifications. Tensolite cables utilize the maximum number of conductors in a minimum of area—saving weight and space. They're available as ribbon cable or in standard round configurations. For demanding applications, we recommend individual conductors of our FLEXOLON wire.

HOOK-UP WIRE

TYPE E-EE TO MIL-W-16878

FLEXOLON WIRE

A new concept in high temperature insulation developed by Tensolite's research and development laboratories. **FLEXOLON** wire provides the best properties of wrapped and extruded fluorocarbon insulation. Important features of this versatile hook-up and lead wire are:

- Solid colors and striped combinations.
- Most flexible of all hook-up wire construction.
- High temperature range of —90 deg. C. to +250 deg. C.
- Greatest miniaturization in MIL-SPEC hook-up wire (smallest hook-up wire in the world).
- High dielectric strength (far exceeds required 600 V and 1000 V ratings).
- Consistent concentricity.
- Superior cut-through resistance.

TENSOLON WIRE

Insulated with TFE fluorocarbon high temperature resin.

Choose from:

Spiral wrapped...with special cross-lapped construction and unlimited color coding; striping that meets commercial and military specifications.

Extruded...featuring an extruded homogeneous Teflon TFE resin (solid and inked stripe combinations).

TENSOLEX WIRE

Insulated with extruded vinyl plastic.

Types B and C meet **MIL-W-16878.** They are high temperature hook-up wires rated for continuous use from —55 deg. C. to +105 deg. C. with or without nylon jackets.

TENSOLEX WIRE

Types WL and SRIR are manufactured in accordance with the joint Army-Navy specification **JAN-C-76** (Qualification approval Certificates Nos. 13725 and 13606A).

Types LW and MW are general purpose hook-up wires specifically designed for radio, instrument, and military electronic applications. Designed to meet **MIL-W-76A**, they are recommended for use at temperatures up to 80 deg. C. in the internal wiring of electrical and electronic equipment.

TENSOLITE WRAPPED VINYL WIRE

Super-flexible wire designed for miniaturization applications at operating temperatures from —40 deg. C. to +60 deg. C.

AIRFRAME WIRE

TENSOLON AIRFRAME WIRE

Insulated with high-temperature resin, it is manufactured in compliance with **MIL-W-7139A.** Important features are:

- —90 deg. C. to +250 deg. C. temp. range.
- 600 Volt and prescribed overload operation.
- Rugged, abrasion resistant construction.
- Short-time operation in event of fire.
- High resistance to chemicals.
- Excellent flexibility.

COAXIAL CABLE

TENSOLON MINIATURE COAXIAL CABLE

Designed to meet **MIL-C-17B**, it is ideal for high frequency operation from —90 deg. C. to +250 deg. C. Insulation assures extremely low loss, high dielectric strength, and complete resistance to moisture and chemicals. A great variety of outer jackets permits the selection of cable well suited for many application requirements.

MAGNET WIRE

TUFFLON MAGNET WIRE

High temperature Teflon insulated magnet wire — designed to meet **MIL-W-19583** — is ideal for coils and windings requiring high temperature application. It is supplied in wall thicknesses ST, HT, TT and QT and AWG sizes 18 through 44.

OTHER PRODUCTS

Ignition Cable	Low Capacitance Cable	Wire Coated with Teflon 100X FEP Resin	Teflon Inks
Asbestos Wire to MIL-C-25038	Air Dielectric Cable	100% Shielded Wire	Bondable Wire
Antenna Wire	Low Noise Cable	Ribbon Cable Shielded and Unshielded	Etched Wire
Thermocouple Wire	Tempered Magnet Wire		High Flex Wire and Cable
	Double Quad Lead Wire		Nickel Plated Conductor

Tensolite INSULATED WIRE CO., INC.

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ENGINEERING FACTS ABOUT

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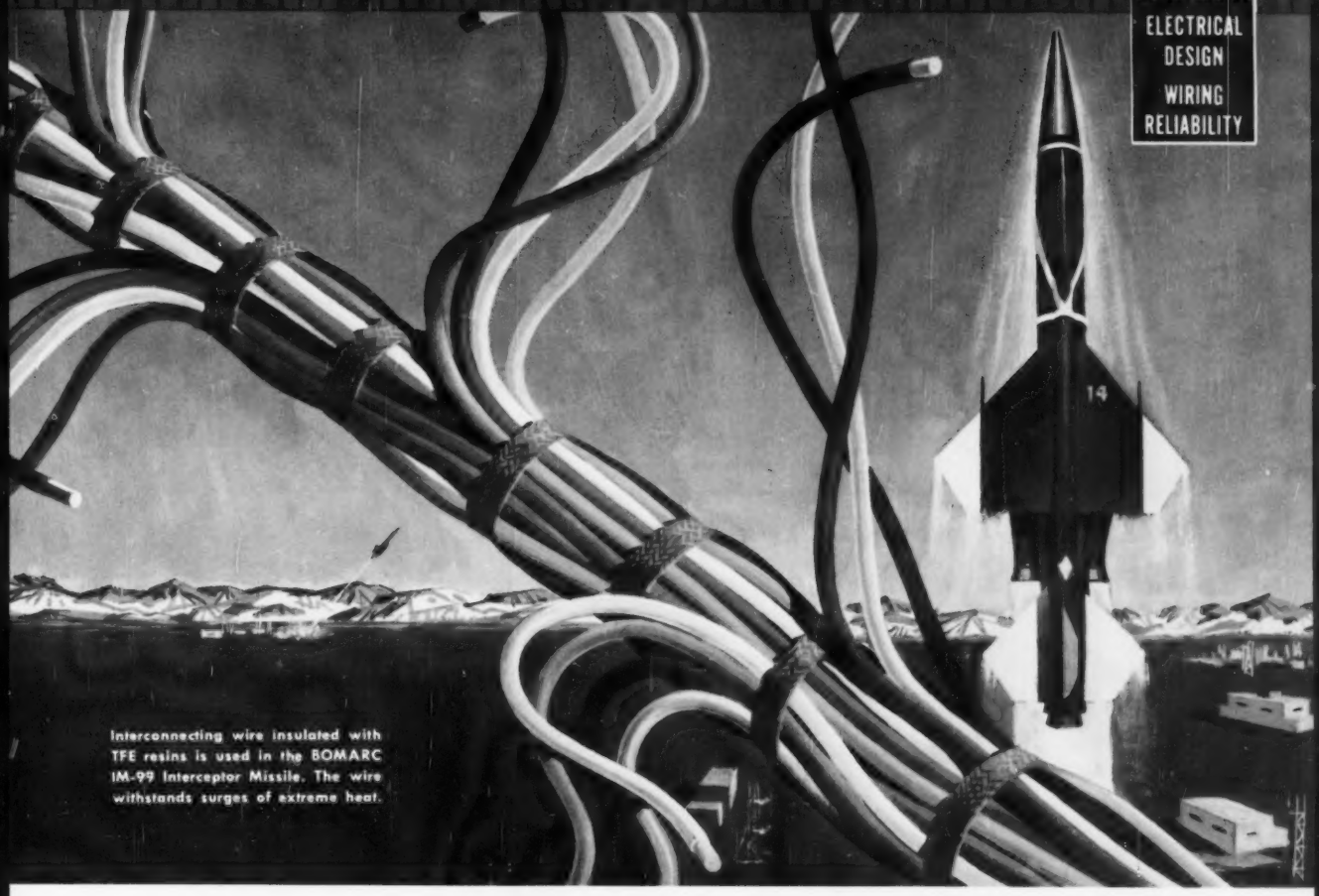
FLUOROCARBON RESINS

NUMBER 2
IN A SERIES
ELECTRICAL
DESIGN
WIRING
RELIABILITY



Interconnecting wire insulated with TFE resins is used in the BOMARC IM-99 Interceptor Missile. The wire withstands surges of extreme heat.

Insulation of TFE resins meets stringent specifications, with cost and weight savings

TEFLON resins are unique as dielectric materials. No other wire and cable insulations are able to offer such outstanding resistance to so great a number of extreme ambient conditions. No other insulations can provide such excellent electrical properties in the face of widely different operating requirements.

In guided missiles, for example, wire and cable insulated with TFE resins must withstand extreme heat, extreme cold, proximity to highly corrosive oxidizers and fuels, exposure to corrosive hydraulic fluids, flexing, vibration, and other mechanical stresses. Yet—under a combination of these conditions—signal and power are delivered with minimum transmission losses.

TFE resins are conservatively rated for a continuous upper operating temperature of 260°C. In intermittent use they can withstand bursts of heat lasting for minutes at temperatures as high as 538°C. (1000°F.). The dielectric properties of TFE-fluorocarbon resins are extremely stable over great ranges of frequency, temperature and time.

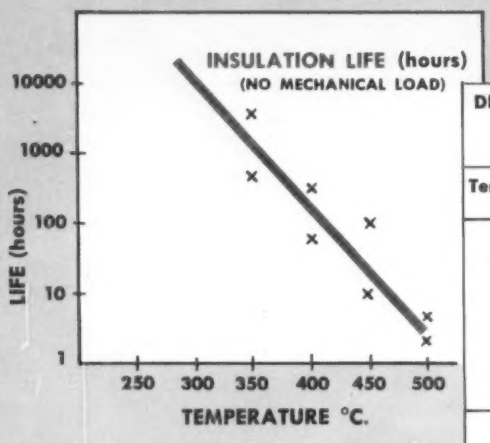
In the next three pages you will see how TFE resins can help you overcome many severe design conditions—with savings in weight, space and costs!

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

OVER

RELIABILITY—key factor in cable insulation under



DIELECTRIC STRENGTH VS. TEMPERATURE*	
Temp. °C.	Diel. Strength (volts/mil)
150	780
250	750
300	760
350	750
400	720
450	610
500	550

*Mil-W-16878C type EE hookup wire, tested in circulating air oven.

TFE resins offer exceptionally long life at high temperatures

Even at 371°C. (700°F.), the weight loss of TFE resins in air amounts to only 2/1000 of 1% per hour! At 427°C. (800°F.), the rate of loss has increased, but only to 15/100 of 1%. These low weight losses account for the excellent heat-aging characteristics of TFE resins. At their rated temperature of 260°C. (500°F.), the life of the resins is estimated in years. Other plastic and elastomer insulations melt, char or disintegrate under the maximum temperature conditions that TFE resins can withstand. The curve of Thermal Life vs. Temperature to the left represents initial data obtained from an extensive program in our laboratories. This curve was formulated by aging hookup-wire samples suspended in an air oven, with test cycles to determine failure including a 2.2 KV wet dielectric test, and a mandrel bend. Details concerning this program are available upon request.

GAR-3 (Falcon) Missile

(Photo courtesy of Hughes Aircraft Co.)

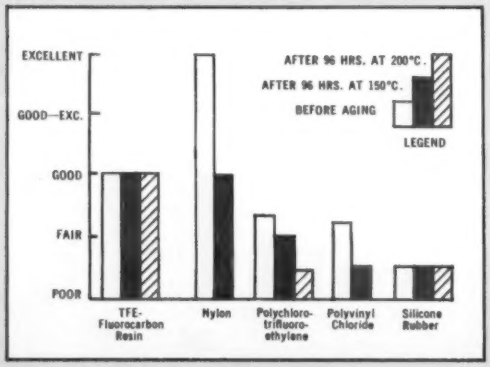
Resistance of TFE Resins to common chemicals		
One-Week Exposure at 212°F.	Dielectric Strength	Tensile-Strength Elongation
"Skydrol" Hydraulic Fluid	Unchanged	Unchanged
Benzene	Unchanged	Unchanged
Carbon Tetrachloride	Unchanged	Unchanged
Ethanol	Unchanged	Unchanged
Red Fuming Nitric Acid	Unchanged	Unchanged
One-Week Exposure at 73°F.		
A-8 Transformer Oil	Unchanged	Unchanged
80 Octane Aviation Gasoline	Unchanged	Unchanged
JP-4 Turbo Fuel	Unchanged	Unchanged
Salt Water	Unchanged	Unchanged
Naphtha	Unchanged	Unchanged
Isopropyl Alcohol	Unchanged	Unchanged

TFE resins are inert . . . unaffected by solvents, chemicals, corrosive gases

TFE resins are inert to nearly all known chemicals. The only exceptions are the alkali metals and fluorine under special conditions and certain fluorinated hydrocarbons at high temperatures. They are unaffected by acids, alkalies, and all organic solvents in any concentration, even at high temperatures. TFE resins are not damaged by any chemical environment that electronic equipment is called upon to withstand. They do not absorb moisture and will pass severe salt-spray tests. Interconnecting wire of TFE resin is specified for the GAR-3 (FALCON) missile (shown at the left), primarily because of its resistance to highly corrosive, lightweight hydraulic fluids.

TAPE ABRASION RESISTANCE*

(MIL-T-5438 Tape Abrader, 400 Grit Tape, ½ lb. load)



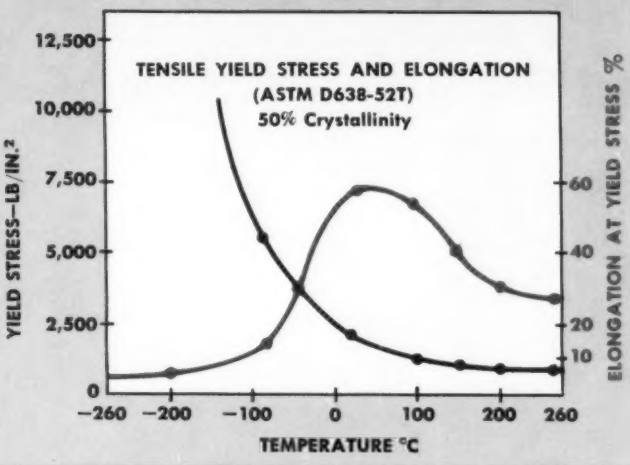
*Measurements made on commercially available hookup-wire samples

TFE resins provide superior mechanical properties . . . resist cut-through and abrasion

Since TFE resins do not melt or flow, even above their crystalline melting point of 327°C. (621°F.), as do ordinary thermoplastic resins, they exhibit outstanding resistance to high-temperature cut-through. The heat of a soldering iron will not cause wire insulation made of a TFE resin to flow or deform. Abrasion resistance and other mechanical properties are unaffected by prolonged aging at any temperature within the recommended operating range.

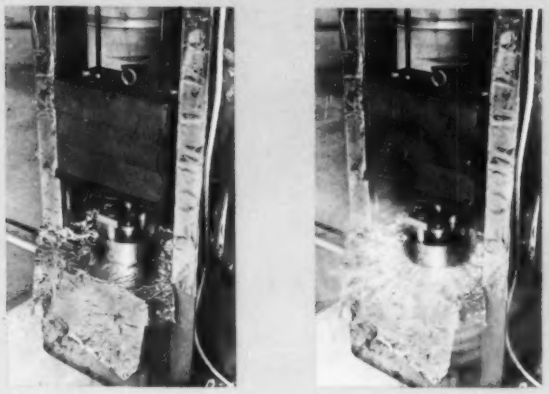
TFE resins have the lowest coefficients of friction of any structural materials, thus simplifying pull-through of wire and cable, and reducing the possibility of shorts due to chafing.

use of TFE resins for wire and toughest environmental conditions



TFE resins provide outstanding performance at low temperatures

TFE-fluorocarbon resins remain tough and strong at low temperatures. At -196°C. (-320°F.), for example, they yield or deform at about the same yield stress as a ductile metal such as annealed aluminum. Under arctic or similar environments of severe cold, wire insulated with TFE resins can be repeatedly bent without cracking, and will not shatter under an impact stress. The curve at the left shows the marked increase in strength of TFE resins as the temperature decreases. Although the elongation decreases, it can be seen that the area under a stress-strain curve (a good indication of mechanical toughness) is relatively unchanged.



(Photo courtesy of the Martin Co.)

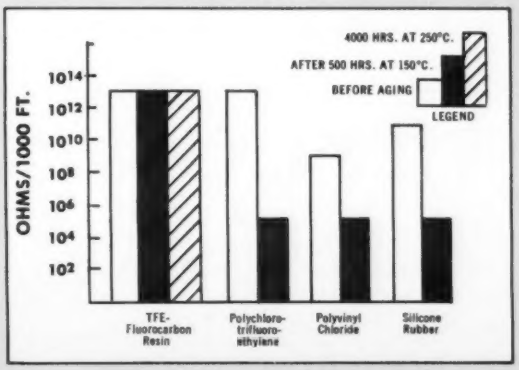
TFE resins are completely compatible with highly reactive materials

In recent tests on materials exposed to liquid oxygen (LOX) and simultaneously subjected to shock, pure TFE resins of all plastics and elastomers did not explode. The pictures at left show the test apparatus and a typical explosion (with a reactive material) taking place in the testing machine used by the Materials Laboratory of The Martin Company, Baltimore.

The inert characteristics of TFE resins allow compatibility in storage and use, even with highly reactive materials. TFE resins do not require plasticizers, UV or heat stabilizers; pliability, UV and heat stability and chemical inertness are built into the polymer molecules.

Wire insulation of TFE resins is also non-flammable, and will not induce flame travel from one area of equipment to surrounding areas . . . a considerable safety factor, both in storage and service.

INSULATION RESISTANCE AFTER ACCELERATED HEAT AGING*



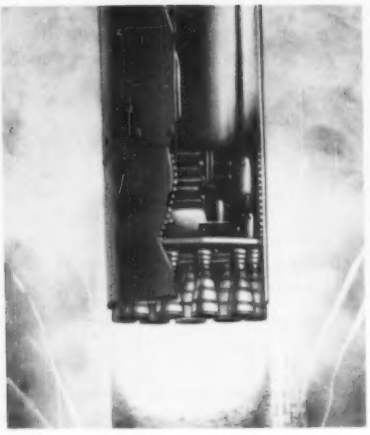
*Measurements made on commercially available hookup-wire samples

TFE resins have excellent dielectric properties within broad rated ranges

The dielectric constant and dissipation factor of TFE resins change less over a wide range of temperatures and frequencies than they do for any other solid material. These values are absolutely constant from below 60 cycles to above 10,000 megacycles and are unaffected by time or heat aging. Short-time dielectric strengths range from 500-4000 volts/mil depending on thickness. After six months of aging at 250°C., the values for dielectric constant, dissipation factor, dielectric strength, insulation resistance, and surface resistance were found to be completely unchanged. Wire insulation of TFE resins, therefore, provides a constant minimum cable capacitance, plus reliable strength and resistance, even under severe environmental stresses.

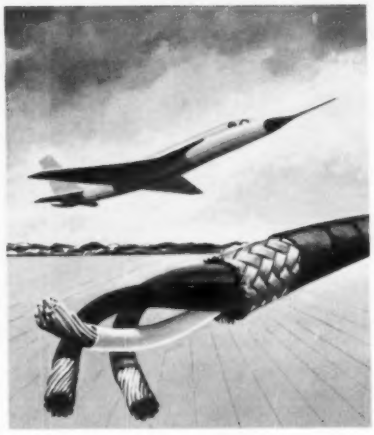
OVER

Insulation of TFE resins meets stringent specifications, with cost and weight savings



ROCKETDYNE—Wire insulated with TFE resins is used to insure maximum reliability in Rocketdyne engines for the Thor and Atlas missiles. In these applications, the insulation must withstand high-temperature overloads, possible exposure to corrosive or reactive missile fuels, the severe cold of liquid fuel temperatures, and extreme vibration and shock. (Photo courtesy of Rocketdyne, a division of North American Aviation.)

DEW LINE—TFE resins were selected as coaxial cable dielectrics for many of the radar circuits for the Dew Line project, to insure reliability in arctic environments. This insulation design enabled considerable weight and space savings for equivalent power capacity, an important factor in arctic transportation. TFE resins maintain excellent dielectric properties despite the cold, and do not crack or embrittle at low temperatures.



NORTH AMERICAN A3J MULTI-CONDUCTOR CABLE—In the design of the A3J Bomber, engineers at North American Aviation found that wire insulated with TFE resins could save precious weight, without sacrificing reliability. This three-conductor cable using primary insulation of Du Pont TFE-fluorocarbon resins enabled a weight saving of 8 lbs. per 1,000 feet of cable. (Photo courtesy of North American Aviation.)

Design specifications involving cramped spaces, tight wiring and high ambients are often best met by wire insulated with TFE resins. The resins simplify assembly. Their excellent high temperature cut-through resistance and high dielectric strength make possible the use of miniaturized types of wire and cable. TFE resins withstand high transient overloads. Soldering-iron and dip-soldering temperatures do not injure them. Their use speeds production.

TFE resins offer a recognized economic advantage over other insulations, even though the others may have a lower initial cost. Savings during manufacture of assemblies, reduced inspection costs, fewer service failures and lower maintenance costs are only a few of the ways TFE resins save money. In aircraft and guided missiles where every ounce of weight lifted requires a large power expenditure, the use of TFE resins is desirable on economic grounds alone.

Insulation of TFE resins is rapidly becoming a design standard where extreme environmental conditions are encountered in service or storage. Even for service where ambient conditions are undemanding, TFE resins are finding use because of *reliability* due to their non-aging characteristics. The service and storage life of equipment can be extended with insulation of TFE resins, regardless of ambient conditions.

FOR MORE INFORMATION . . .

You'll want to know just what types of wire and cable insulated with TFE resins are available for your use. Call your local supplier of TFE-fluorocarbon resins for product and property data (he's listed in the Yellow Pages under "Plastics"). For any unanswered technical question about these resins, write to: **E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept., Rm. 2524, Nemours Bldg., Wilmington 98, Delaware**

In Canada: *Du Pont of Canada Limited, P. O. Box 660, Montreal, Quebec*

TEFLON *is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.*

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TFE-FLUOROCARBON RESINS

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A MILLION FEET KEPT IN FACTORY STOCK *

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BY

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VERSATILITY IN WIRE SIZES — Rex carries in stock standard sizes of Teflon insulated hook-up wire, from #32E to #10EE.

VERSATILITY IN EXPERIENCE — Rex has had long experience extruding Teflon TFE Resins, Teflon FEP Resins and other halogenated materials — can wrap and jacket with Teflon and Teflon-impregnated Fiberglas.

VERSATILITY IN FACILITIES — Rex is your best source for all types of high temperature hook-up wires, miniature coaxial and multi-conductor cables — has cabling facilities second to none among Teflon insulators.

Rex Durastriping for color-coding is indestructible — better than inks. Rex special cables always receive 100% inspection. Rex's testing laboratory is qualified to perform under Mil Q-5923.

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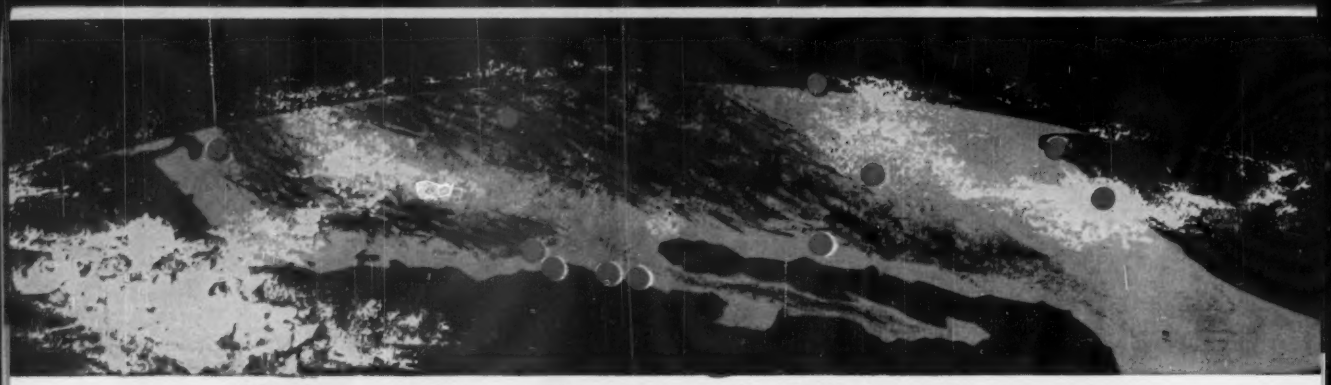
CIRCLE 16 READERS SERVICE CARD



Where the shape of things to come

is programmed by AMPEX tape recorders

The profiler above is shaping parts for new Lockheed Electras. Exact tool positions are being defined by command signals—as many as 200 per second—from the Ampex FR-100 in the control system to the right of the machine.

The accuracy of such a milling operation increases with the number of points defined per inch of tool motion. One reel of magnetic tape defines millions of points, programming up to 1½ hours of continuous machine operation. Recycling a tape loop will program an entire run of identical work-pieces.

Shaping parts by command signals from Ampex-equipped automatic control systems is now routine production operation at such places as Lockheed in Burbank, Martin at Denver, Rohr at Chula Vista, Convair at Ft. Worth and San Diego, and Giddings & Lewis at Fond Du Lac, to mention only a few.

Even though punched cards and paper tape are still proving adequate for many of today's less-sophisticated automatic control installations, systems engineers are increasingly interested in the superior speed and data-handling advantages of magnetic tape. An Ampex FR-300, for instance, can extract a short burst of digital information equal to that on an entire punched card in less than 4 milliseconds, including start and stop.

In configurations like the one illustrated, the advanced Ampex FR-100A, with its 14 tracks on 1-inch tape, has ample reserve for extra functions. Six tracks may be used for tool-position coordinates; others for start, stop, coolant, or even voice instructions.

Whether you believe the future of automatic control lies in point-to-point positioning, continuous-path control, or both—Ampex magnetic tape recorders have built-in reserve capabilities which make them worthy of consideration as a component for any control system designed for tomorrow's needs.

First in magnetic tape instrumentation

AMPEX
CORPORATION

AMPEX INSTRUMENTATION DIVISION
934 Charter Street, Redwood City, California
Offices in USA and Canada. Engineering representatives cover the world.

CIRCLE 17 READERS SERVICE CARD

Consumer Shares Hold Firm

As 1959 MOVES into its second quarter, financial reports from consumer electronics firms indicate a favorable financial position and good prospects for the year.

• **Philco Corp.,** Philadelphia, has begun implementation of an agreement with **Thorn Electrical Industries, Ltd.,** London. Terms call for making Philco's designs and developments in radio and monochrome tv available to Thorn for manufacture and sale in the United Kingdom. In addition, Thorn acquires all issued capital stock of Philco (Overseas) Ltd., the Philadelphia company's radio and tv unit in England.

• **Zenith Radio Corp.,** Chicago, announces record sales of $195,041,624, a 22 percent increase for 1958 over the $160,018,978 total for 1957. Profits for last year came to $12,116,165 or $12.30 a share, compared with $8,165,577 or $8.29 a share in 1957.

• **Electro Voice Inc.,** Buchanan, Mich., has offered 150,000 shares of common stock on the public market through F. S. Moseley & Co., N. Y. Net proceeds will be used for retiring short-term loans and adding to plant facilities. Consolidated net sales for the Michigan firm last year totaled $8,493,419, an increase of $1,302,457 over 1957. The firm's principal products include speaker systems, microphones and audio equipment.

• **Olympic Radio and Television,** Long Island City, N. Y., reports expectations of a high sales peak during the early part of this year. This is based on an increase in January of 33 percent over the same period in 1958. Public interest in stereo is seen as the spur.

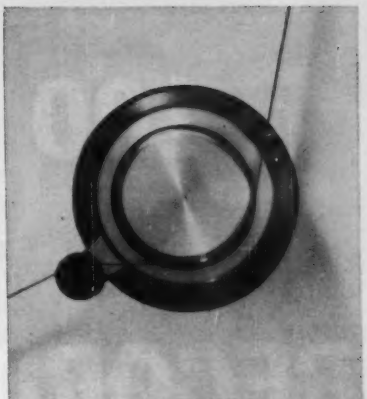
• **The Magnavox Co.,** Ft. Wayne, Ind., reports that sales for the first half of this year look promising although a slight dip in earnings was noted for the last half of 1958. Net earnings during that period totaled $2,222,000, as compared with $2,407,000 for the first six months of last year. The firm reports back orders of "well over $40 million in both industrial and military products."

• **Admiral Corp.,** Chicago, reports a small decline in 1958 sales which totaled $170,777,126, compared with $172,663,167 in 1957. The difference in earnings is reportedly due to operating losses by the firm's new discontinued plastics division.

OVER THE COUNTER

1958 BIDS LOW	1958 BIDS HIGH	COMMON STOCKS	WEEK ENDING Mar. 20 BID	Mar. 26 BID	Mar. 26 ASKED
3¾	20½	Acoustica Assocs	29	38	44
1⅜	3	Advance Industries	3½	3¼	4
3⅛	6⅝	Aerovox	6⅞	8¼	9¼
5½	15	Appl'd Sci Princet	11½	10¼	12¼
1⅛	8⅞	Avien, A	8¼	8⅝	10
6¾	24	Baird-Atomic	27	27¼	31¾
9¾	13⅜	Burndy	16½	15¾	17¾
6¾	9	Cohu Electronics	8⅜	8¼	9⅛
11	22½	Collins Radio, A	31½	33½	37¾
10¼	22¼	Collins Radio, B	31½	33½	37¼
4	7	Craig Systems	9⅜	10¼	11⅜
17⅛	25⅛	Eastern Industries	22	20	23⅞
1¾	8⅜	Elco Corp	8⅝	8½	9⅝
10½	21	Electro Instr	27¾	28¾	32
34	49	Electronic Assocs	46	41	47¾
5	11	Electronic Res'rch	20	19	23
8½	12¾	Electronic Spec Co	13¼	14¼	15⅜
15¼	49½	Epsco, Inc	36	38	45⅝
5½	9⅜	Erie Resistor	9¾	9⅝	11¼
10	17½	Fischer & Porter	15⅜	15¾	17¾
5½	10½	G-L Electronics	15	15¼	17
12	27	Giannini	27¼	29	32¾
...	...	Haydu Elec Prod	5¼	5¼	6½
30	39½	Hewlett-Packard	43½	47¾	51⅝
23¼	48	High Voltage Eng	64½	55	66½
1¾	3	Hycon Mfg	4¼	3⅝	4⅞
1⅛	5⅛	Industro Trans'tor	3½	4½	5⅝
...	...	Internat'l Rec'f'r	—	26¾	29⅜
...	...	Interstate Engin'g	—	31½	34⅝
1½	4¾	Jerrold	5¾	6⅛	6¾
21	30	D. S. Kennedy	31¾	33¼	37¾
33¼	29	Lab For El'tronics	36¾	35	39⅝
19¼	28	Leeds & Northrup	29¼	28½	31½
2	3⅛	Leetronics	2⅝	3⅛	4¼
5	18¾	Ling Electronics	23	25¼	29⅛
3¼	8¼	Magnetic Amplifiers	10	10	11⅝
2⅞	4½	Magnetics, Inc	5¼	5⅛	5¾
4⅝	12	W. L. Maxson	13⅜	13¼	16⅛
10⅝	29	Microwave Assocs	40	43	48¼
5¼	11¾	Midwestern Instr	11⅝	11	13⅛
1⅛	7	Monogram Precis'n	11¾	13¼	15⅛
3½	7¼	Narda Microwave	7	7¾	9⅛
...	...	Narda Ultrasonics	8½	11½	13⅛
9¾	16	National Company	21½	20¾	23¼
14¼	56	Nuclear Chicago	40	39	44
4½	7⅜	Pacific Mercury, A	13¼	12¾	15⅛
10⅛	27½	Packard-Bell	40	40½	44
4¼	9⅜	Panellit, Inc	7½	7⅜	8⅜
21	53¾	Perkin-Elmer	49½	45¼	51⅞
11⅜	19½	Radiation, A	21¾	23¾	25⅞
2⅛	7⅜	Reeves Soundcraft	8¼	7⅞	9⅛
13	32½	Sanders Associates	27	28½	32½
...	...	Silicon Transistor	7¼	9½	11½
7	12	SoundScriber	19½	18	20⅛
22¾	40	Sprague Electric	43½	44½	49
26	35	Taylor Instruments	36½	36¼	39⅝
5½	15	Technical Operat'ns	—	22	35⅝
5½	15¾	Telechrome Mfg	21	24½	29⅞
3¼	7¾	Telecomputing	11¾	12¼	14½
1⅛	2¾	Tel-Instrument	2¾	2½	3
8¾	16¼	Topp Industries	13¼	14¼	16⅝
3¾	10¾	Tracerlab	12¾	12½	14⅜
1⅛	3⅜	Universal Trans'tor	⅞	⅞	1⅛
14¼	40	Varian Associates	46¾	49¾	55¼

The above "bid" and "asked" prices prepared by the NATIONAL ASSOCIATION OF SECURITIES DEALERS, INC., do not represent actual transactions. They are a guide to the range within which these securities could have been sold (the "BID" price) or bought (the "ASKED" price) during preceding week.



AMPEX:
turning point for tape

Magnetic recording has reached the point where a better tape, by itself, can significantly improve the performance of your equipment. Anticipating this, Ampex has developed its Instrumentation Tape to assure the highest capability that the state of the art requires.

Precision tape reliability comes principally from the properties of its coating. And Ampex combines oxide preparation and careful coating techniques with the exclusive Ferro-Sheen process to produce the smoothest, most cohesive, most uniform of precision tapes. The result is measurably higher signal-to-noise ratios, and much less tape wear.

This, with its squared-up hysteresis curve, makes Ampex Instrumentation Tape ideal for all recording systems: direct, FM-carrier, PDM, and NRZ-digital.

Ampex Instrumentation Tape is available on hubs, NAB-type or die-cast magnesium - alloy Precision Reels. Widths of ¼", ½" and 1" are standard on either Mylar* or acetate base, in the following lengths, reel diameters, and base thicknesses:

AMPEX STANDARD TAPE LENGTHS (feet)

REEL DIAMETER	BASE THICKNESS (mils) 1.0	1.5
7"	1800	1250
10½"	3600	2500
14"	7200	5000

*DU PONT TRADEMARK

For complete specifications or additional tape literature, write

AMPEX MAGNETIC TAPE

934 CHARTER STREET, REDWOOD CITY, CALIF.

CIRCLE 18 READERS SERVICE CARD

100 CPS X-Y RECORDING

with immediate readout

THE NEW SANBORN MODEL 670 OPTICAL X-Y RECORDER HAS

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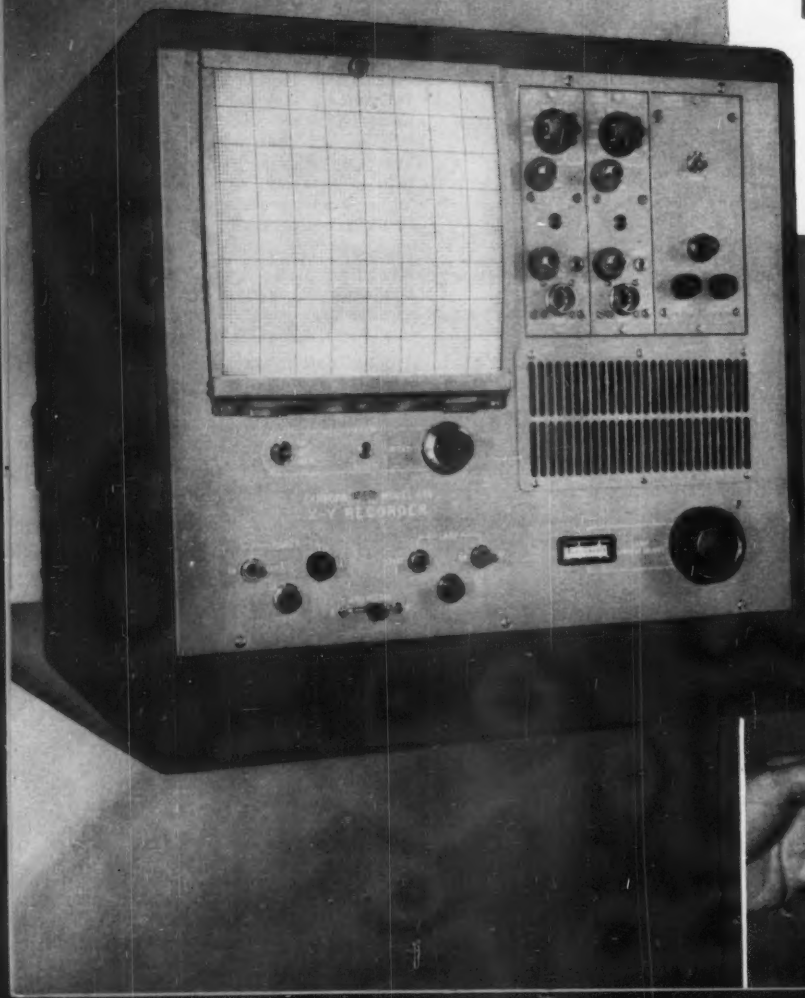
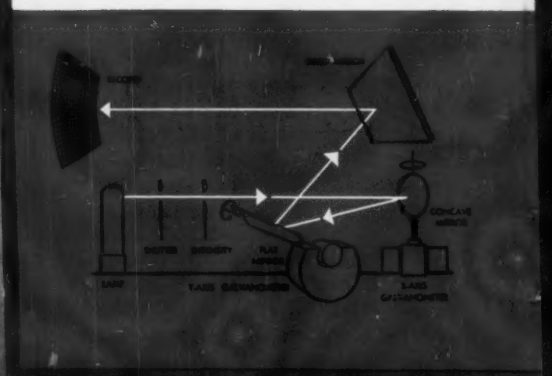
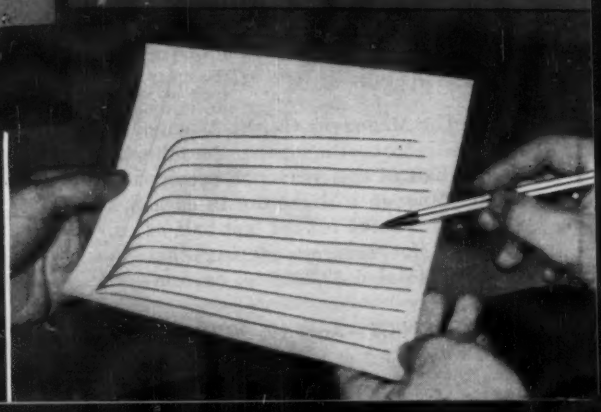
- ★ frequency response 3 db down at 130 cps independent of amplitude
- ★ writing speeds to 2500 in/sec.
- ★ 8" x 8" direct print paper chart
- ★ trace monitoring on phosphorescent screen



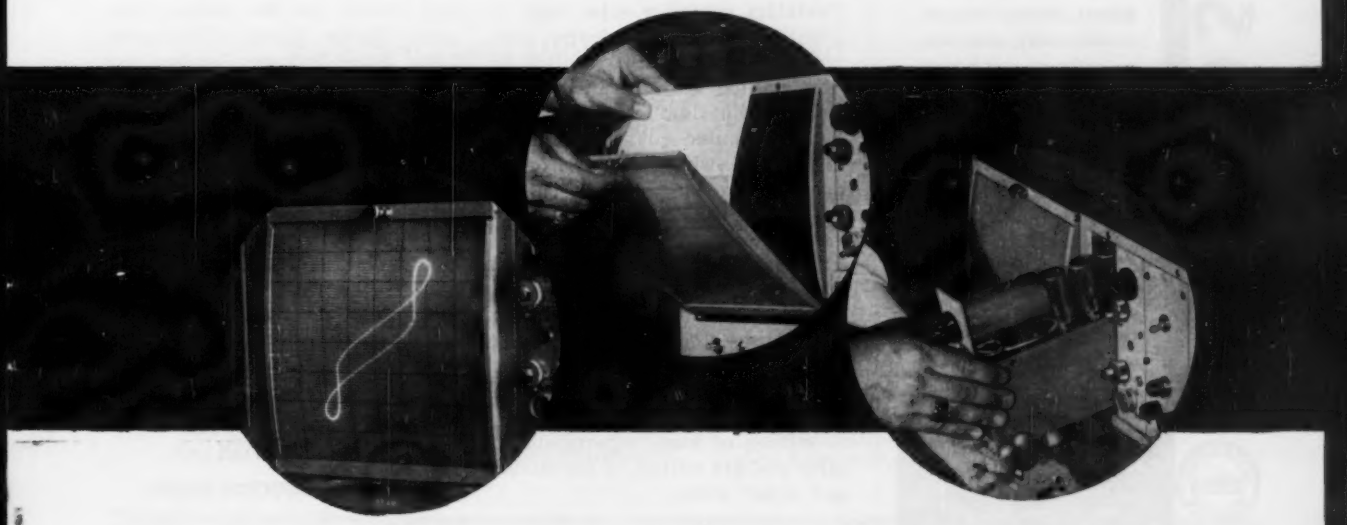




X-Y RECORDING never before possible with electromechanical instruments can now be done with the new Sanborn Model 670 X-Y Recorder. Direct writing on ultraviolet-sensitive recording paper by a beam deflected by optical galvanometers makes possible the combination of fast writing speed and 130 cps frequency response not found in any other X-Y recorder. Transistor characteristics, acceleration and vibration of mechanical parts and events of similar short duration can be recorded with linearity of *1% of full-scale* and at trace speeds as fast as *2500 inches per second*. Square wave response exhibits no greater than ½% overshoot *at any amplitude;* sensitivities as high as 62.5 uv/inch (depending on preamplifier used).

PLOTS OCCUPY AN 8″ x 8″ RECORDING AREA and can be previewed or monitored on the instrument's phosphorescent screen. An Axis Record switch to print X and Y axes on the record, and a Beam Intensity Control to assure maximum trace clarity, are among the front panel controls provided. An 8″ x 8″ sheet of the ultraviolet-sensitive chart paper (stored in drawer at base of cabinet) is easily placed on the back of the hinged screen. Brief post exposure in normal room light is the only developing process.

OPTIONAL INTERCHANGEABLE PREAMPLIFIERS for each axis presently include the Model 850-1300B DC Coupling and Model 850-1200 Phase Sensitive Demodulator; a Carrier Preamplifier, High Gain Preamplifier and a time base generator are now in development. Driver Amplifiers are compact, fully transistorized plug-in units with single-ended input and output. Galvanometers are low resistance, low voltage units of rugged, enclosed construction; sensitivity and damping are independent of coil temperature. Accessible, unitized circuitry also extends to the power supplies—a front-panel plug-in for both preamplifiers and a second supply for both driver amplifiers. A built-in blower provides constant, forced filtered air cooling. The Recorder can be rack mounted in 15¾″ of panel space, or housed in its own 20″ x 20″ x 21¼″ optional portable cabinet.



Ask your local Sanborn Sales-Engineering Representative for complete information on the Model 670 X-Y Recorder, or write the Industrial Division in Waltham, Mass.

SANBORN COMPANY

INDUSTRIAL DIVISION • 175 Wyman Street, Waltham 54, Massachusetts

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In laboratories and other applications where critical requirements must be met, there is no room for second best. Vitreosil possesses properties of greatest value for: ultra-violet applications, metallurgical investigations, chemical research, photochemistry, spectroscopy, and many uses in physical, optical and electrical research as well as product operations.

Vitreosil is available in an unusually wide variety of types and sizes—Or, we'll be happy to fabricate to your specifications. *Write us about your requirements today. For your convenience, use the coupon below. See our ad in Chemical Engineering Catalog.*

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Predicts Boom for New Diode

PARAMETRIC amplifier diode industry sales will total many million units annually within three years, predicted Paul Petrack, silicon products manager for the ITT Components division, at its recent industrial sales meeting.

The parametric diodes will be widely used as high speed switching devices in computers and long range communication, Petrack says. Computer use will be especially heavy.

By 1962 average unit price of the parametric amplifier diode is expected to drop to about $1.50. This diode was introduced on the market only a few months ago at average price of $150. Price quickly dropped to $35.

Silicon diode and rectifier industry sales this year will top $50 million, says Bob Deutsch, division's field sales manager. Estimate is almost double sales of $26 million in 1958. New zener diodes will get sizable chunk of the 1959 total, about $9 million, he says.

Combined industry sales of tantalum capacitors and glass seals will hit $33 million, Deutsch says. Tantalum capacitor sales total in 1958, according to industry estimates, was about $20 million or nine million units. ITT's production of tantalum capacitors has been in limited quantities. But it expects to swing into large scale production soon.

Selenium rectifier industry market still looms large, says Walter F. Bonner, division's selenium products manager. Sales will total $22 to $23 million in 1959, he says. This estimate compares with sales of $26 million in 1958 and forecast of sales of $19 million in 1960. At present market is divided between $5 million of home entertainment sales and $18 million of industrial and other sales.

• **Development cycle** for new components can be materially shortened by developing applications along with the component, says Charles Thornton, vice president of ITT Labs. For instance, ITT shaved two years off the normal component development span for a new parametric amplifier diode by parallel development of the application, an r-f amplifier subsystem for a display unit. Integration of component and application development efforts provided division's sales force with a ready-made component market, Thornton points out.

• **Military demand** will result in rising sales of special resistors for the next few years. Needs are for low wattage hi-stability resistors (1/8th watt or less) of the deposited carbon and metal film types. Demand for these resistors for use in military equipment is expected to be 50 percent greater in 1959 than it was in 1958. Current average usage rate of these resistors to transistors in military equipment is 2½ to 1, some authorities claim. Unit prices range from seven cents to almost a dollar, with considerable demand for the higher priced types.

• **Ultrasonic equipment** sales added up to $25 million in 1958 and should hit $50 million this year, claims Narda Ultrasonics Corp. Some industry leaders say there will be a $150-million annual market for ultrasonics equipment within five years.

• **Magnetic tape sales** volume will reach $40 million at retail value in 1959, predicts Frank B. Rogers Jr., executive vice president of Reeves Soundcraft Corp. The many tape recorders sold in the past few years has increased the market considerably, he adds.

FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	Mar. 20, 1959	Feb. 20, 1959	Change From One Year Ago
Television sets	94,648	115,909	+3.5%
Radio sets (ex. auto)	269,051	273,854	+57.7%
Auto sets	100,804	106,066	+150.6%

STOCK PRICE AVERAGES

(Standard & Poor's)	Mar. 25, 1959	Feb. 25, 1959	Change From One Year Ago
Electronic mfrs.	80.63	76.18	+54.0%
Radio & tv mfrs.	95.96	86.66	+106.4%
Broadcasters	94.30	84.25	+61.1%

Subminiaturization—*State of the Art*

The trend to new techniques in subminiaturization *has* brought up some weird approaches! While there may be some merit to the technique illustrated, there is a definite shortage of little people.

Although this trend to smaller and smaller systems and components presents certain production problems, reliability is never sacrificed at Hughes. To provide you with subminiaturized products that stand up under the most severe of environmental conditions, Hughes utilizes the most advanced equipment in the industry.

The following three pages give you three specific examples of reliable Hughes components. You'll find full details on Hughes Zener diodes, TONOTRON* storage tubes, and precision crystal filters.

In addition to these, other Hughes Products devices which provide you with this "built-in" reliability include: special-purpose oscilloscopes... precision crystal filters...rotary switches...thermal relays...MEMOTRON® and TYPOTRON® display storage tubes...diodes, transistors and rectifiers with uniform performance...and industrial systems which automate a complete and integrated line of machine tools.

*Trademark of H.A.C.

For additional information regarding any component or system please write: Hughes Products, Marketing Dept., International Airport Station, Los Angeles 45, California.

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

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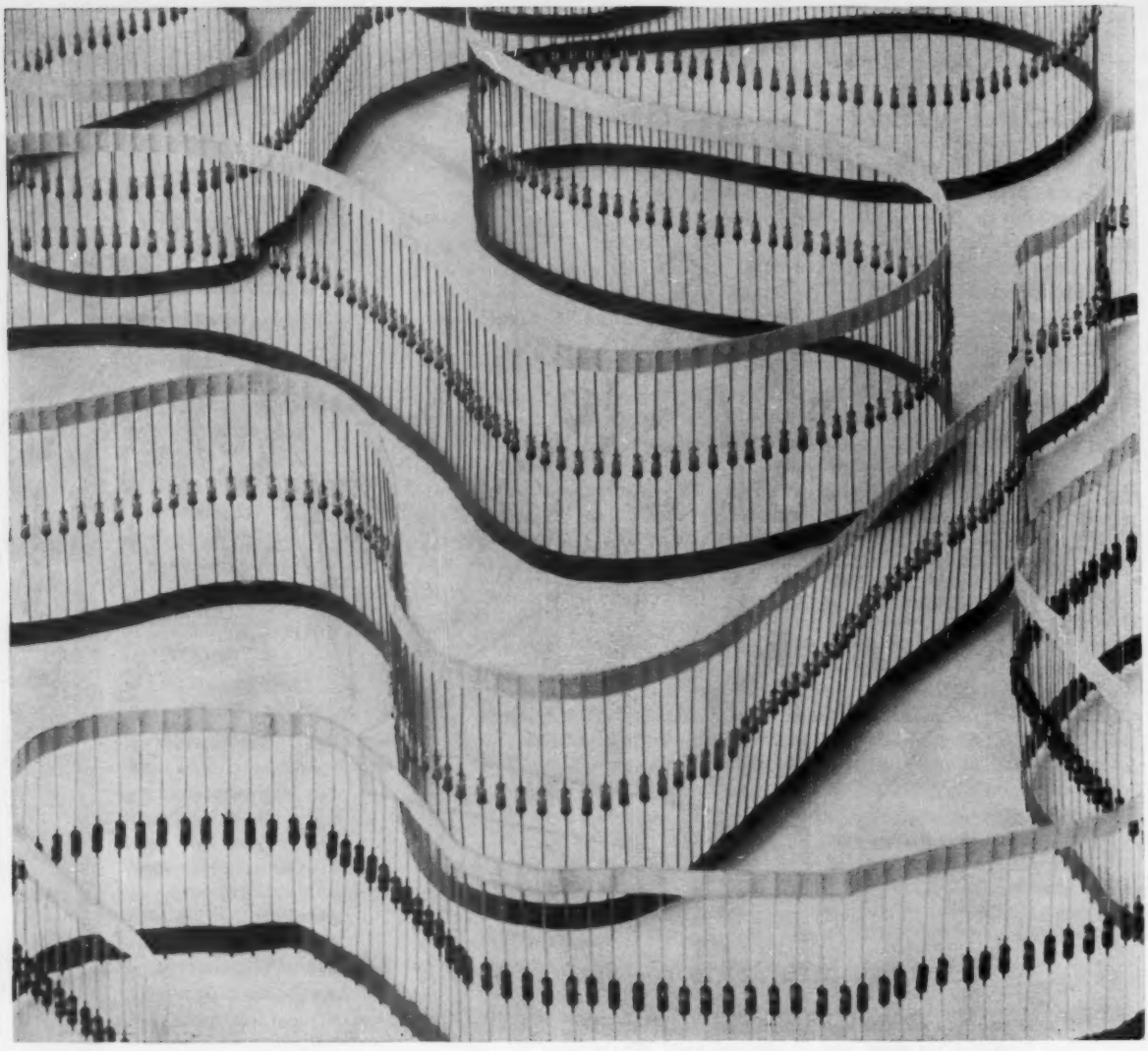

ZENER DIODES IN A PROVEN GLASS PACKAGE

Now you can get high-performance voltage-regulator diodes in the famous, hermetically-sealed Hughes glass envelope. These diodes have an outstanding characteristic: sharp regulation of reverse voltage. This means that you can use them—with confidence—in clipping, clamping, coupling, and compensation circuits to obtain *dependable voltage regulation*. In addition, they retain this stability, together with low dynamic resistance, throughout a wide range of operating temperatures.

CHARACTERISTICS

Nominal Voltage: 2 volts to 30 volts
Power Dissipation: 250 milliwatts
Maximum Dynamic Resistance: 10 to 75 ohms
Operating Temperature Range: —65° to 175° C.
Dimensions, Diode Glass Body: Maximum Length: 0.265″ max.
Maximum Diameter: 0.105″ max.

To obtain your copy of specifications covering the family of more than a dozen types of Hughes Silicon Voltage-Regulator Diodes, please write: Hughes Products, Semiconductor Division, Marketing Department, P.O. Box 278, Newport Beach, California.

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THE FIRST 21″ STORAGE TUBE

High light output! Controlled Persistence! Full gray scale!

The Hughes 21″ TONOTRON* tube offers you a new level of sophistication in displays for: Air traffic control, Combat situation plotting, Radars, Large-scale read-out, Medical diagnosis, Industrial television, and Slow-scan displays.

This new TONOTRON tube provides high light output, integration abilities, full gray scale, controllable persistence, and a very large display area—all in one envelope!

Hughes also announces a 21″ character-writing TYPOTRON* storage tube, which gives you the *added* capability of high-speed digital character display. The 21″ TYPOTRON tube is ideally suited for any of your digital read-out requirements. In addition, this unique TYPOTRON tube offers you either character read-out or spot writing modes—or a combination of both capabilities.

Both the 21″ TONOTRON Tube and the 21″ TYPOTRON tube are now available for delivery. For additional information please write: Hughes Products, Electron Tubes, International Airport Station, Los Angeles 45, California.

Creating a new world with ELECTRONICS

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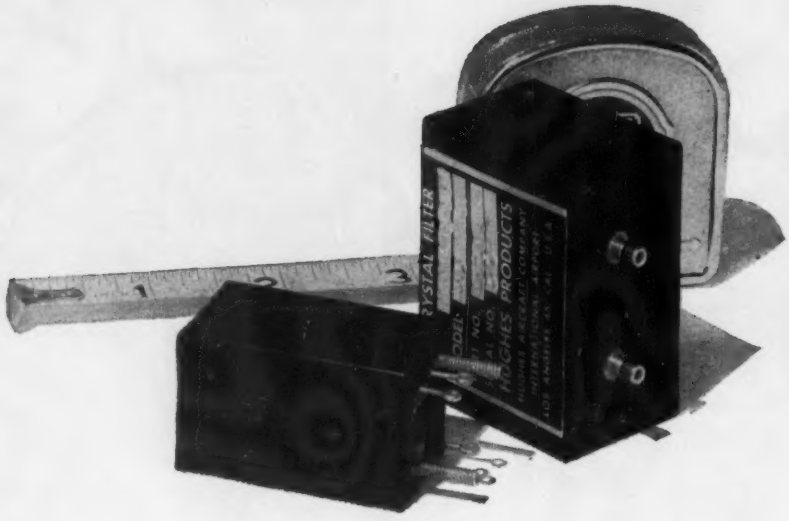

PRECISION PERFORMANCE LEVELS set by Hughes Crystal Filters

Now you can obtain high performance crystal filters previously available only for special military developmental contracts and Hughes-built systems. Utilizing unique design and advanced manufacturing techniques, these Hughes crystal filters provide a degree of performance previously unobtainable.

These crystal filters have center frequencies of 30 kc to 30 mc. In addition, you can take advantage of seven distinct features:

1. High frequency filtering
2. High selectivity
3. Low passband ripple
4. Low insertion loss
5. Small size and weight
6. Excellent temperature stability
7. Excellent shock and vibration stability

A complete engineering service for network and filter design is available to you. To obtain specifications for crystal filter types currently available, or for information concerning engineering capabilities, please write: Hughes Products, Marketing Dept., International Airport Station, Los Angeles 45, California.

TYPICAL BANDPASS FILTERS DELIVERED BY HUGHES PRODUCTS

	No. 1	No. 2	No. 3
Center Frequency	30 mc	10 mc	6 mc
6 db bandwidth	170 kc	40 kc	2 kc
60/6 db bandwidth ratio	1.35	2.3	1.4
Minimum Stop-band Attenuation	60 db	60 db	60 db
Maximum Passband Ripple	±1 db	±0.6 db	±0.75 db

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IN '59:

NEW LOOK...
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NEW PERFORMANCE...

for the famous

WESTON 301 panel instrument series!

Yes . . . the trusted, familiar WESTON 301 LINE has undergone a big change this year. You'll find these 3½-inch, pace-setting instruments looking different . . . doing more for you . . . working better and longer.

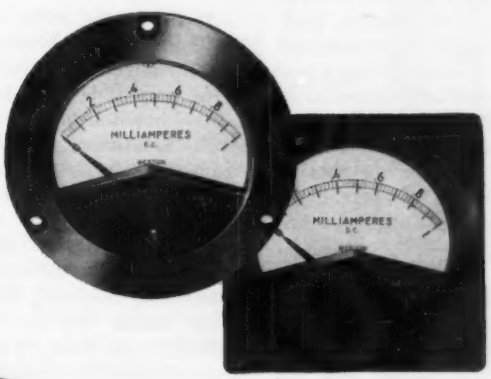
The renowned Cormag® mechanism, now standard, permits mounting on magnetic or nonmagnetic panels, close to other instruments, without special adjustments. It makes the "301" immune to the effects of stray magnetic fields.

The new 301 line is available in D-C, R-F and A-C rectifier types, as well as in moving iron A-C types with capabilities of obtaining controlled ballistic characteristics – even including critical damping.

A new, modernistically styled, Bakelite case – round or rectangular – is standard in this completely new line. These cases are interchangeable for A-C and D-C models.

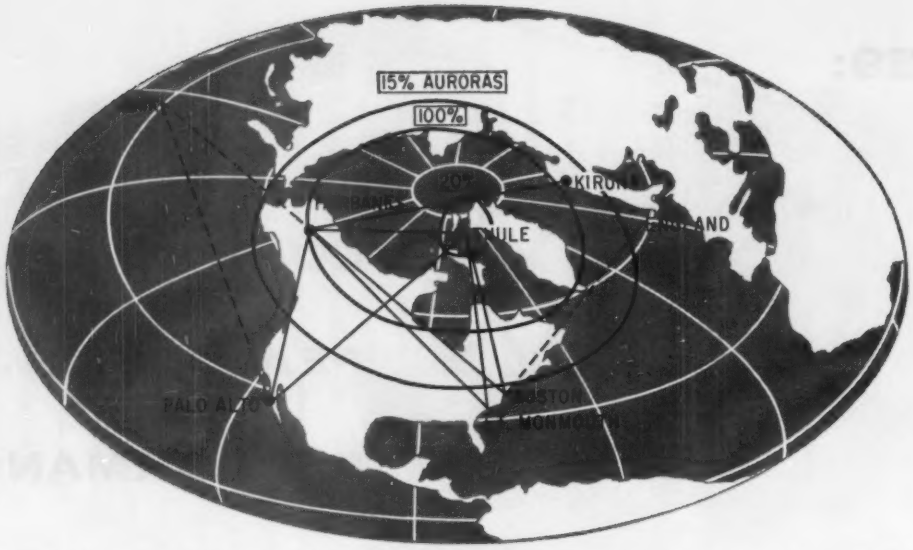
You'll be interested, too, in the new 2½-inch Weston panel instruments – the 201 group. They match in appearance the 301 group and incorporate the same new features.

For full information, contact your local Weston representative . . . or write to Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. *In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.*



WESTON *Instruments*

A DAYSTROM UNIT



Polar projection map shows auroral belts, propagation paths used by Arctic blackout study teams. Solid lines indicate paths now in use; broken lines, proposed additions

Why Missile Signals Fail

Air Force radioastronomy and propagation teams on two continents investigate auroral effects on celestial, earth-based signals

CELESTIAL, earth-based radiation piercing top-of-world auroral zones is under investigation by Air Force on two continents in stepped-up programs for vital missile, space travel information.

Radioastronomy and communications techniques are expected to yield significant data for missile detection and guidance, trans-auroral and transpolar communications, astronavigation, and earth-ship communications for space vehicles.

Sites, Contractors

Sponsored by Cambridge Research Center and Rome Air Development Center, researchers are working at U. S. field stations from Boston to Palo Alto; in Fairbanks, Alaska; Thule, Greenland; Adak in the Aleutians; Kiruna in northern Sweden; and at five sites in Norway.

Participating contractors include Stanford U., Stanford Research Institute, Avco, Harvard, University of Alaska Geophysical Institute, Sweden's Kiruna Observatory and Norwegian Defense Research Establishment, Air Force says.

Using the radio stars and the sun as tools, radioastronomy researchers want to find out what happens to signals from outer space when they pass through the ionosphere and troposphere, particularly in auroral zones.

Groundwork for radioastronomy and communications studies is laid by mapping auroral zones and probing state of the ionosphere at various times.

Aurora is basically a particle stream resulting from solar flares.

Under direction of Jules Aarons, AFCRC team is conducting backscatter experiments at Plum Island, 40 miles from Boston. Using a yagi on rotating mast and transmitting in 18 mc region, researchers plot aurora by means of ppi screen, also probe structures and heights of ionospheric layers, measure depth and rate of change of auroral zones.

New Program Starts

Sponsored by Rome ADC, Stanford Institute is conducting experiments in Fairbanks to determine effect of aurora on vhf and uhf radars. Experimental radars are operated at frequencies of 200, 400 and 800 mc. Sixty-foot parabolic reflectors, horn fed, comprise antenna system. Transmitters vary in average power from 20 kw at 400 mc to 5 kw at 800 mc.

AFCRC started new phase of atmospheric propagation effects program this month at Sagamore Hill, Hamilton, Mass. Reoriented program is follow-up of earlier work on astral rf emission, uses "point" radio star sources instead of sun as transmitter.

Measure Scintillations

At Fairbanks, under sponsorship of Rome ADC, University of Alaska's Geophysical Institute is measuring amplitude and phase scintillations imposed on radio waves by Arctic ionosphere. Emissions from radio stars in Cygnus and Cassiopeia are being monitored. A phase switch, phase-sweep and phase track interferometer system consisting of two sidereally-driven, equatorially-mounted, 28-foot parabolas, spaced 300 feet apart and aligned East-West, are used to measure scintillations. System operates at 223 and 456 mc.

In northern Sweden, above the Arctic Circle, Kiruna Observatory

researchers under contract with AFCRC are studying auroral propagation characteristics. Swedish team is recording transpolar signals sent at 12 and 18 mc from IGY transmitter at College, Alaska, and studying absorption of cosmic ray energy by ionosphere. Effect of aurora on noise background is also being explored.

Also at Kiruna, radioastronomy equipment in 35 to 65 mc range is being used to study auroral effects on apparent star motion—what occurs in way of scintillation and refraction.

Studying Ionosphere

To help build geographically valid picture of auroral effects on signals, AFCRC has installed absorption data equipment at five field stations conducted by Norwegian Defense Research Establishment. They study absorption of cosmic noise in ionosphere.

AFCRC ionospheric studies directed by Hallock S. Marsh concentrate on Arctic blackout, using hf, principally in 12, 18 and 30 mc bands. Ionospheric receiving equipment monitors Thule and Fairbanks 12 and 18 mc sounder signals, as part of AFCRC in-house work.

Stanford U., under AFCRC contract, is instrumenting stations at Palo Alto, Boston, Ft. Monmouth and Fairbanks for synoptic study of 12 and 18 mc sounder signals from Thule and Fairbanks. Adak may eventually be fifth station.

Broad spread will reveal scope of Arctic ionospheric disturbances, whether general or fairly local. Stations will receive same signal simultaneously at 3 frequencies, to give idea of auroral effects and amount of absorption in heavily ionized regions.

Stanford will analyze data, set up special studies to supplement routine amplitude and multipath mode observations. With aid from Harvard, it will analyze lf-vlf info around hf blackout periods.

Avco is investigating possibilities of forecasting anomalous refractive, scintillation and absorption effects, with special emphasis on northern latitude problems.

Upcoming in AFCRC program: study of round-the-world echoes and attempted correlation with Arctic anomalies.

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Yes, your customers are *always* right . . . *when there's no proof to the contrary.* But when you can prove *on the record* that performance is up to guarantee, then there's no further argument. And you can give them that record by building into your product a Veeder-Root Counter as a standard, integral part . . . to count in any terms or units your customers could want. This is easy to do . . . and inexpensive, too. Let us figure it out for you. Write.

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High Speed, Quick Reset REVOLUTION COUNTER

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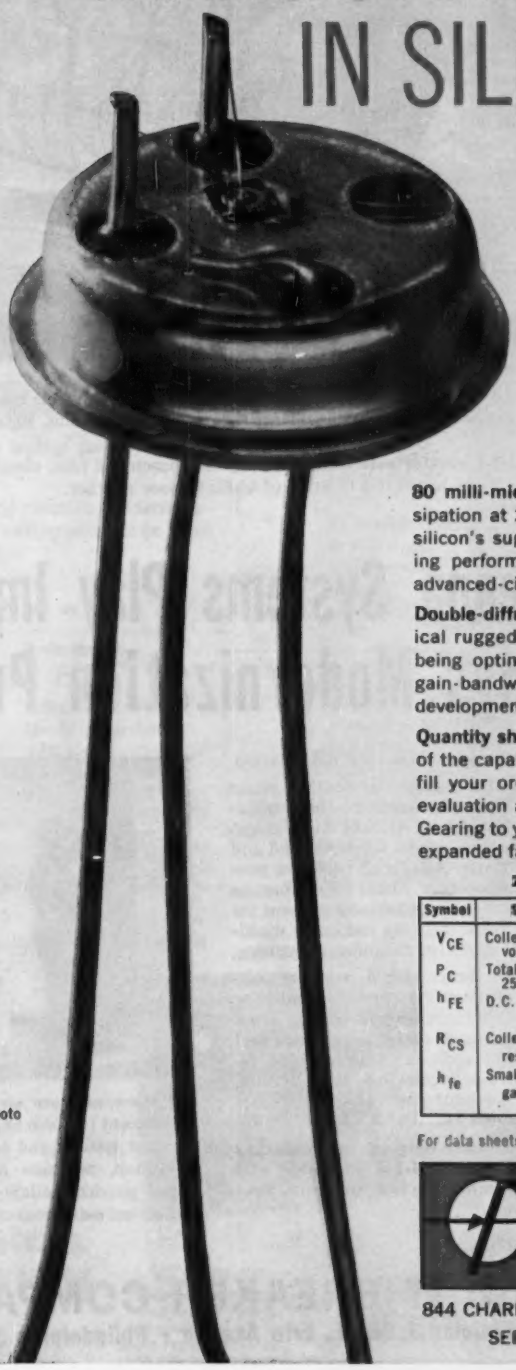
FROM FAIRCHILD

MESA TRANSISTORS IN SILICON



Greatly enlarged photo of Fairchild 2N696 before capping

80 milli-micro-second rise time with 2 watts power dissipation at 25° C. This speed and power is combined with silicon's superior high-temperature reliability. The switching performance that this affords has a place in every advanced-circuit evaluation program.

Double-diffused mesa-type construction provides mechanical ruggedness and excellent heat dissipation besides being optimum for high-frequency performance (typical gain-bandwidth product 80 Mc). This type is under intense development everywhere. Fairchild has it in production.

Quantity shipments now being made give conclusive proof of the capabilities of Fairchild's staff and facilities. We can fill your orders promptly. You can start immediately on evaluation and building of complete prototype equipment. Gearing to your future production needs, Fairchild will have expanded facilities to over 80,000 square feet by early '59.

2N696 and 2N697 — NPN SILICON TRANSISTORS

Symbol	Specification	Rating	Characteristics	Test Conditions
V_{CE}	Collector to Emitter voltage (25°C.)	40v		
P_C	Total dissipation at 25°C. Case temp.	2 watts		
h_{FE}	D.C. current gain		2N696—20 to 60 2N697—40 to 120	I_C=150ma V_C=10v
R_{CS}	Collector saturation resistance		3.5Ω typical 10Ω max.	I_C=150ma I_B=15ma
h_{fe}	Small signal current gain at f=20Mc		5 typical	I_C=50ma V_C=10v

For data sheets, write Dept. A-4

FAIRCHILD SEMICONDUCTOR CORPORATION

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Added performance for added safety. New I-T-E antenna system will extend the range of airport surveillance radars to 50 miles radius, 30,000 ft. coverage.

I-T-E circular polarization feed system penetrates rain, clouds and dust to give more positive location of traffic in poor weather.

Advanced I-T-E Antenna Systems Play Important Roles In FAA Airways Modernization Program

Surveillance radars at major airports throughout the country will soon be equipped with completely new antenna systems for added safety in the control of jet age air traffic. This project will mark the second phase in the FAA's program to improve their performance and extend their range. I-T-E has participated in both phases.

Initially, I-T-E developed and supplied kits for adapting circularly polarized feed to existing ASR-2 and -3 antennas. This modification provided clearer, more easily observable scope displays, uncluttered by echos from clouds, rain or dust. And now, under a new FAA contract, I-T-E has embarked upon the design and production of 50 replacement antenna systems which will extend the range of ASR-1, -2, and -3 surveillance radars to 50 miles, coverage to 30,000 feet. The new systems will also provide the advantages of circular polarization.

I-T-E is also engaged in another phase of airways modernization—the production of TACAN (TACtical Air Navigation) antenna systems for both land and shipboard use. Advanced types are now under development. Other I-T-E antenna projects range from compact systems for ultraprecision tracking radars to multi-megawatt giants for distant early warning.

If you are faced with a problem concerning antenna systems—for radar or scatter communications—benefit from I-T-E's extensive design experience and production facilities. Address your inquiry to I-T-E Special Products Division, and ask for your copy of I-T-E's valuable Antenna Handbook (2nd Edition).

Engineers: Challenging opportunities are available at I-T-E in radar and scatter communication antenna system design.

For more accurate air navigation. I-T-E technicians perform final tests on TACAN antenna systems and control consoles. In operation, precision modulated antenna signal provides suitably equipped aircraft with direct indications of range and bearing.

I-T-E CIRCUIT BREAKER COMPANY
Special Products Division • 601 E. Erie Avenue • Philadelphia 34, Pa.

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MICROWAVE GENERATORS

950 to 21,000 mc

with MORE MODULATION CAPABILITIES

The extremely wide range of pulse width, delay and repetition rate are read directly on the front panel of Polarad microwave generators. In addition these units provide broadband internal FM and CW modulation, versatile external modulation capability and a sync output for all signals. These features provide the largest choice of microwave test signal combinations available in signal generators.

Internal pulse rise and decay: 0.1 microsecond.*

External pulse modulation: positive or negative polarity, 10 to 10,000 pps, 0.2 to 100 microseconds width.*

Output synchronization pulses: positive polarity, delayed and undelayed.

Rugged construction. Quick, easy inspection and servicing. Continuous UNI-DIAL tuning in each frequency range. Non-contacting tuning cavity chokes.

For every application, 950 to 21,000 mc.

Model	Frequency Range	Power Output
MSG-1	950 to 2,400 mc	0 dbm (1 milliwatt) to −127 dbm, directly calibrated
MSG-2	2,000 to 4,600 mc	
PMX	4,200 to 8,000 mc 6,950 to 11,000 mc	
MSG-34	4,200 to 11,000 mc	
PMK	10,000 to 15,500 mc 15,000 to 21,000 mc	+10 dbm (10 milliwatts) to −90 dbm

AND MICROWAVE POWER SOURCES — 1,050 to 17,500 mc.

High power output: 14 to 700 milliwatts depending on frequency. **Modulation:** Internal square wave or external FM and square wave.

MODULATION CAPABILITIES*

Generates CW, FM, internal pulse, internal square wave. Or can be externally modulated.

Pulse delay: adjustable from 2 to 2,000 microseconds.

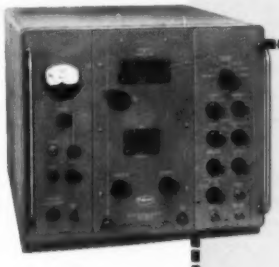
Pulse repetition rate: adjustable from 10 to 10,000 pps.

Pulse width: adjustable from 0.2 to 10 microseconds.

Linear sawtooth internal FM modulation, 10 to 10,000 cps, 5 mc minimum frequency deviation.

Internal or external, pulse or sine wave synchronization.

*Models MSG-34, PMX and PMK



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☐ Microwave Power Sources,

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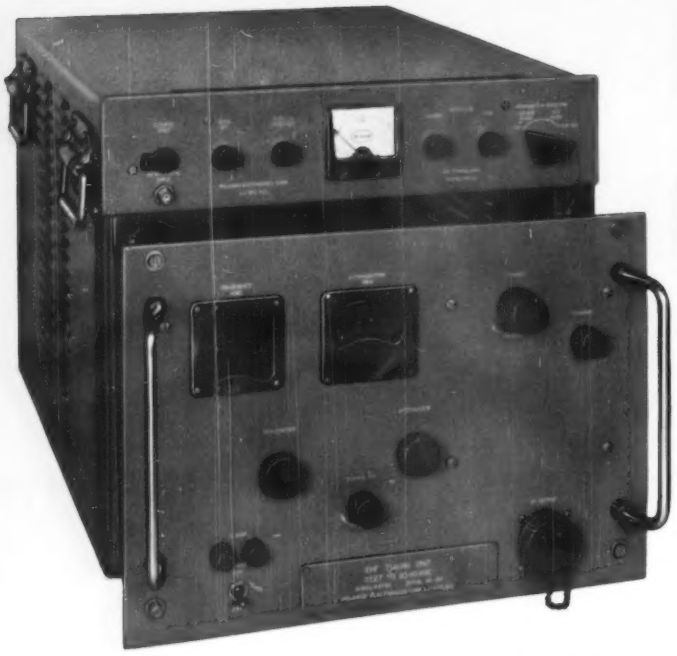


MICROWAVE GENERATORS

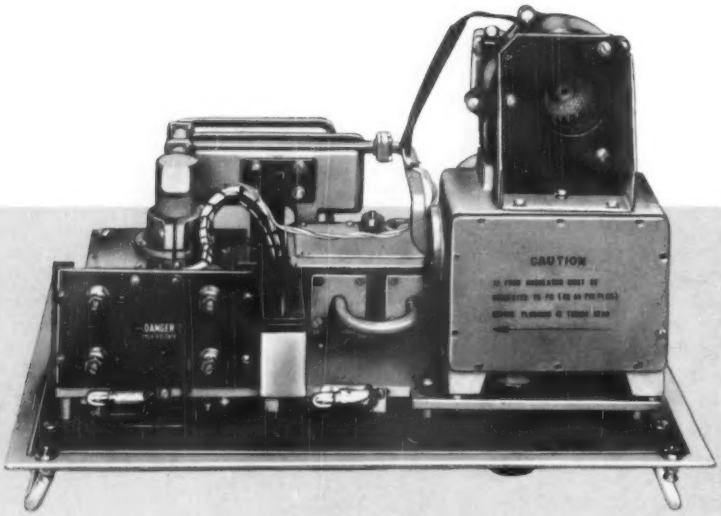
18,000 to 50,000 mc.

MICROWAVE SIGNAL GENERATORS
18,000 to 39,000 mc

7 interchangeable plug-in tuning units
Calibrated power output: —10 to —90 dbm
Direct-reading attenuator, accurate to 2%

MICROWAVE POWER SOURCES
18,000 to 50,000 mc

9 interchangeable plug-in tuning units
High power output: 10 mw from 18,000 to 33,520 mc.
Between 9 and 3 mw in higher ranges, depending on frequency.



PLUG-IN INTERCHANGEABILITY

Now you can work at Extremely High Frequencies with one basic microwave generator, using only the tuning units in the ranges you require immediately. Later, as your work expands to other frequencies, **add only tuning units — not complete generators.**

All instruments provide: a direct reading wavemeter, indicating frequency to 0.1% accuracy; continuous tuning over entire range; 1,000 cps internal square-wave modulation — or external modulation; direct waveguide output connectors. All are designed for quick, easy inspection and servicing.

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Marketing Revolution Spreads

Single sales source for commercial products cuts distribution costs, permits automated system of inventory controls for distributors

REVOLUTION in commercial electronic parts distribution is evoking trade-wide comment this week as major manufacturers voice enthusiasm for recently-installed marketing systems.

"This is no longer a product-oriented business," says John T. Thompson, manager of Raytheon's 10-month-old Distributor Products Division.

"Where once the emphasis was on manufacturing, it's now on distribution. Logistics of distribution represent two-thirds of cost - - - engineering and production only one-third."

Raytheon's DPD, though an internal marketing agency, is charged with full profit-and-loss responsibility. Consolidated source of supply has its own merchandising, trade relations and market research organization. It purchases outright from manufacturing divisions, has full responsibility for inventory control, and is the company's single sales source for distributors.

DPD has no role in government sales, which are negotiated directly with Federal agencies, nor in sales to original equipment manufacturers. But original equipment sales system includes "cutoff point." If OEM sale is under specified quantity, transaction will be steered through Distributor Products Div.

In some areas of country, DPD works through district managers; in others, through manufacturers' reps. Outside of the U. S., the company sells through its International Division.

Only factory-dealer relationships remaining in the firm's commercial sales structure are in marine products, where only 350 dealers are involved; and, in Radarange, 120 dealers.

In addition to stocking complete line of receiving tubes, semiconductors, magnetrons, power tubes, industrial tubes and other components, DPD also stocks and sells non-Raytheon products, such as tv picture tubes. The division controls the quality of non-Raytheon products, which carry the Raytheon label. "We buy engineering and manufacturing," DPD Manager Thompson points out. He sees the possibility of a substantial marketing field in product families which are his firm's interests.

Aid to Company

Besides making money for the division, marketing of another firm's products can be as beneficial to manufacturing divisions and the company as a whole. A distributing division can build a market first, then maybe convince manufacturing divisions to get into the business. In a sense, a distribution section's sales history of product is best possible type of market research.

Across-the-board marketing division, plus distribution of outside companies' products, also provide cross-fertilization in sales, engineering, manufacturing. Feedback from the company's sales force is a helpful byproduct.

Integral part of the distribution operation is an automated distributor-stocking plan which keeps lower inventory levels on distributors' shelves, reduces stocktaking, accelerates flow of tubes to them.

How It Works

Past sales, inventory records for two years are studied in setting up a controlled inventory.

With inventory levels for various tubes established, coded IBM cards are inserted into each five-pack of tubes on distributor's shelves. As packages are used to fill dealer orders, clerk places key-punched card into collection box in stockroom. Box is emptied daily, part of it going to the manufacturer's automated warehouse and constituting part of weekly order. Stub from card remains with distributor for checking purposes.

At warehouse, automatic card reproducer punches full-size IBM card with tube type, unit price, distributor's identification number. Automatic sorter classifies tube in ascending numbers, then tabulator totals quantity of each type needed to replace last week's sales by distributor, and extends price.

Output of tabulator becomes packing slip for warehouse and invoice for distributor. Each new carton contains a new card.

Invoices are mailed from warehouse when tubes are shipped. Customers' terms are 2 percent discount on invoices paid 40 days from invoice date, thus eliminating peak purchasing tied to calendar months.

Inventory control levels can be increased by placing a conventional purchase order noting that new shipment should include controlled inventory cards. Inventory can be lowered by withholding cards.

Tomorrow's problems are discussed at Raytheon's new distributor products division

"Tiny" Yewell takes the stand for electronics

Paul G. Yewell is president of Yewell Associates, Inc., Burlington, Massachusetts — an electronics manufacturers' representative firm.

Manufacturers' representatives play a key role in the distribution of electronics products and equipment, accounting for a far larger portion of the sales of instruments and components than do representatives in the average American industry. This type of technical selling is a highly specialized business, in the case of Yewell Associates, Inc., requiring graduate engineers, trained as salesmen, capable of discussing detailed specifications or demonstrating instrumentation or other products.

During 1958 the eight firms that "Tiny" Yewell represents ran a total of 150 ⅔ pages of advertising in **electronics.**

Mr. Yewell, do you consider your manufacturers made a wise media selection in concentrating so many advertising pages in electronics magazine?

"Definitely, I have been reading **electronics** *for years and consider advertising in the publication is fundamental in any sales program aimed at the electronics industry. Its advertising pages constitute a veritable 'supermarket' of electronics products and services being manufactured today."*

If it's about electronics, it's advertised and read in **electronics**

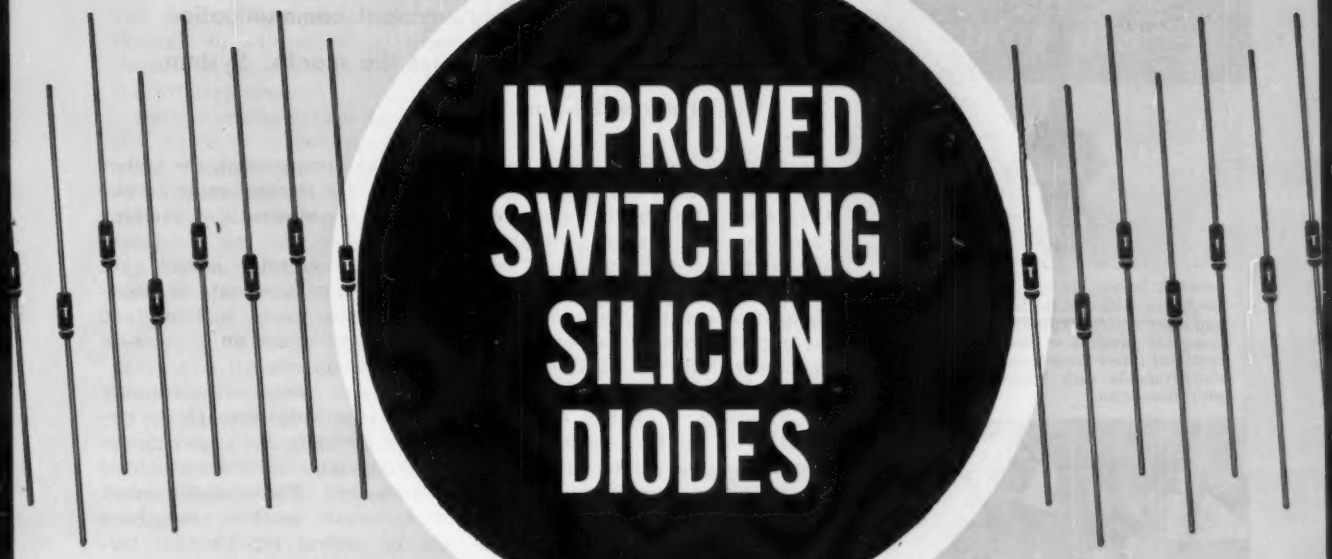
electronics

Published WEEKLY plus the mid-year electronics BUYERS' GUIDE

A McGraw-Hill Publication • 330 West 42nd Street, New York 36, N. Y.

CIRCLE 34 READERS SERVICE CARD→

A NEW PRODUCT FROM TRANSITRON...



IMPROVED SWITCHING SILICON DIODES

Transitron's advanced solid-state development program has now produced the industry's most versatile selection of computer switching diodes.

High forward conductance and 0.3 microsecond inverse recovery are combined with low 125°C leakage currents. The performance of logic circuits in the 10 ma region is improved with the low capacity (3 $\mu\mu$f) 1N806-1N807 diodes. Higher current circuitry can be reliably operated using 1N808-1N809 diodes.

For less stringent temperature environments, Transitron also provides a selection of standard 100°C fast switching diodes.

Production quantities of all types are immediately available from stock. Small quantity requirements can be obtained from your authorized Transitron distributor.

FAST SWITCHING SILICON DIODES, SUBMINIATURE GLASS PACKAGE

Type	Minimum Forward Current @ 1 V (ma)	Max. Rev. Current @ Specified Voltage (μa. @ volts) 25°C	Max. Rev. Current @ Specified Voltage (μa. @ volts) 125°C	Minimum Saturation Voltage @ 100 μa. (25°C) (volts)	Reverse Recovery (256 JAN) Max. Rec. Time μsec	Rec. Level μa	I ma	V volts
1N809	100	1.0 @ 200	50 @ 200	220	0.3	350	30	35
1N808	100	1.0 @ 100	50 @ 100	110	0.3	350	30	35
1N807	4*	.5 @ 175	50 @ 175	200	0.3	100	5	40
1N806	4*	.5 @ 100	50 @ 100	110	0.3	100	5	40
		25°C	100°C	25°C				
1N663	100	5 @ 75	50 @ 75	100	0.5†	200	5	40
1N658	100	.05 @ 50	25 @ 50	120	0.3	500	5	40
1N659	6	5 @ 50	25 @ 50	55	0.3	88	30	35
1N660	6	5 @ 100	50 @ 100	110	0.3	88	30	35
1N661	6	10 @ 200	100 @ 200	220	0.3	88	30	35
1N643	10	1 @ 100	15 @ 100	200	0.3†	200	5	40
1N662	10	20 @ 50	100 @ 50	100	0.5†	400	5	40

*Maximum 1 mc capacity = 3 $\mu\mu$f (—10 Volts)
† IBM Modified "Y" Circuit
Temperature Range —55°C to 150°C

For complete data, write for bulletins PB-51 *and* TE-1350.

TRANSISTORS • RECTIFIERS • DIODES • REGULATORS • VOLTAGE REFERENCES

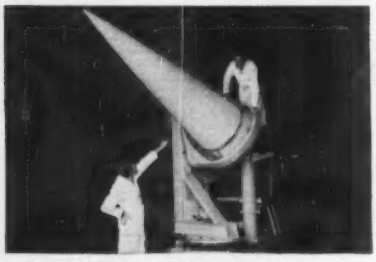
Transitron

electronic corporation • wakefield, massachusetts

Why Boeing offers
ENGINEERS
better opportunities

BOMARC, backed by one of the largest production orders in the field of missiles, and other rapidly expanding missile and space-age projects at Boeing offer exceptional career opportunities. Openings also available with Minuteman solid-propellant ICBM.

Boeing research facilities, most extensive and complete in the industry, give you the solid backup you need to grow in professional stature and get ahead faster. Precision microwave interferometer, above, typifies creative assignments open now in Research, Design, Production, and Service.



Engineers working in radar and communications are supported by self-sufficient Boeing laboratories, housing equipment such as nation's first automatically recording, precision boresight error range, above. Other openings in infrared techniques, radar and beacon systems, electronic circuitry, and guidance and control systems.

Write *today* for your free copy of the 24-page book "Environment for Dynamic Career Growth." Indicate your degree(s) and field of interest. Address: Mr. Stanley M. Little, Boeing Airplane Co., P.O. Box 3822 - ENB, Seattle 24, Washington.

BOEING

Big Army Contracts

Study award for Army's global communication system, UNICOM, will be let this month. System will provide full-time circuits

FIRST STUDY contract for Army's new global communications system, UNICOM (Universal Integrated Communication System), will probably be awarded by the end of this month. More than 25 firms reportedly submitted bids to study the gigantic project that compares in scope with that of USAF's global communication system, AIRCOM, (ELECTRONICS, p 14, Feb. 27).

UNICOM will be a complete system, connecting points within the U. S., between continents, to support areas and into combat areas, tying in on a compatible basis with each local tactical system employed.

A common system will handle all the major requirements of military communication—command control, warning, weapons systems, intelligence and logistic and administrative communication support.

What It Offers

UNICOM will provide:

- User-to-user service (men and machines)—in addition to store-and-forward service;
- Fully automatic circuit and message switching;
- Automatic integral on-line encryption and decryption;
- Standardized signaling rates, transmission systems and components.
- Automatic and manual terminal instruments;
- Automatic error control;
- Integrated data manipulation, processing and storage capability;
- Increased transmission speeds;
- Multi-mode operation (voice, teletypewriter, data, facsimile, and video); and
- Improved trunking means and configuration.

Some of UNICOM'S key details:

The basic switching plan of UNICOM is circuit switching. Since a great volume of military traffic does not require the instantaneous service provided by the circuit-switching arrangement, the system provides for message-relay service through electronic switching centers.

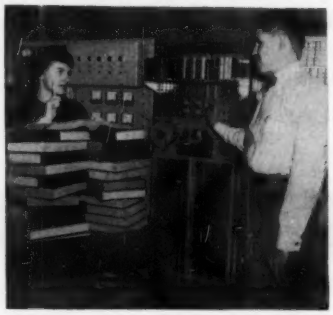
Full-time circuits provide the ultra-speed requirements of weapons systems, early warning and critical intelligence on a point-to-point basis.

Direct customer-to-customer service is provided through the circuit switching exchanges which operate similarly to automatic dial switchboards. The customer—man or automatic machine—can have any of several input/output terminals such as voice instrument, a graphic device, a printed page, or any of several data transmission or electronic data processing kinds of equipment.

Complete security is provided by the on-line automatic security devices included as an integral part of each switching center. Data processing equipment in the Automatic Data Service Center will perform filtering and analysis operations on intelligence data which require such processing.

Automatic monitors, integral to the switching centers, sense the

Searches Data



Tubeless memory machine with 22-track magnetic tape transport developed by ITT Laboratories spins tape past "read-write" head at 500 ft per minute and conducts data research at rate of 30,000 characters per second.

Due Soon

continuity of each leg of the circuit and cause automatic restoral through an adjacent or alternate channel in the event of failure of the primary channel.

Early warning data is sent from the source to various agencies located through the world with a speed-of-service of less than one minute. When weapons systems are integrally tied into the early warning system, full-time circuits with automatic restoration may be used.

Speeds of service through the Automatic Message Exchange depend upon the message length and precedence assigned. For messages of approximately 100 words in length, a speed of service in the order of one minute will be achieved when right-of-way precedence is assigned.

Digitalized Data

Nominal information rates of 3.5 kc, 50 kc and 5 mc will be accommodated by the trunk circuits. Exact rates and bandwidths are being considered by a Joint Committee on Communication Standards.

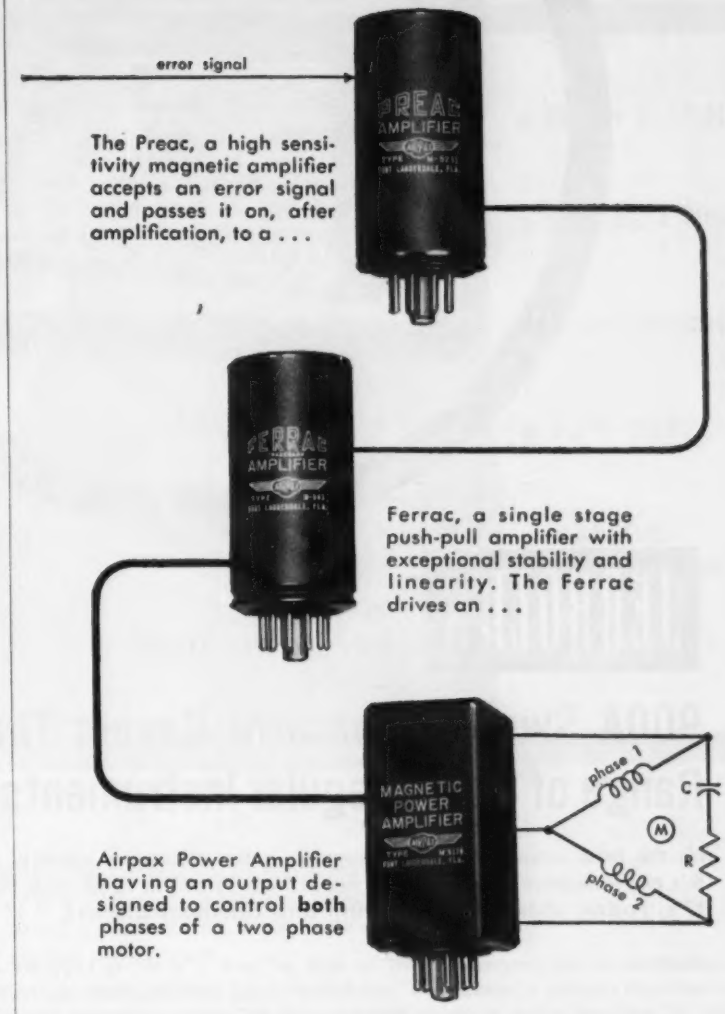
All transmitted information, including that which is basically analog (voice, graphic, video) appears in encrypted, digitalized form utilizing standardized rates over the common transmission system. Error-control devices are incorporated in the transmission channels, in accordance with the inherent reliability of the particular medium used to derive the channel.

By 1965, UNICOM may have high altitude communication satellites in a stabilized orbit providing wide-band, real-time global communications. As an interim program, satellites will be utilized as couriers of bulk intercontinental message traffic.

Troposperic scatter communication is presently available; however, drones and lighter-than-air vehicles are being studied and tested for use as elevated microwave repeaters to provide wide band, real-time communications to meet this forthcoming requirement.

AIRPAX

produces complete systems as well as components



The Preac, a high sensitivity magnetic amplifier accepts an error signal and passes it on, after amplification, to a . . .

Ferrac, a single stage push-pull amplifier with exceptional stability and linearity. The Ferrac drives an . . .

Airpax Power Amplifier having an output designed to control **both** phases of a two phase motor.

All units are hermetically sealed and meet or exceed pertinent military specifications for temperature, shock and vibration.

Completely encased system or individual components

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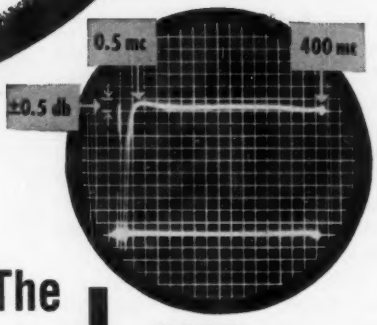
SL4

SEMINOLE DIVISION • FORT LAUDERDALE, FLORIDA



JERROLD'S *versatile new*

900A Sweep Generator Covers The Range of Three Regular Instruments!

It's the most *versatile* Sweep Generator in the electronics industry... this one instrument covers *all* your needs from ½ MC to 1200 MCS, for **IF's, radar, video, telemetering and communications!**

Specifications: In two ranges—0.5 MC to 400 MC and 275 MC to 1200 MC—the instrument supplies a sweep signal with center at any frequency from 500 KC to 1000 MC and with sweep widths as broad as 400 MC and as narrow as 100 KC. The RF output—carefully monitored by matched, crystal diodes feeding a two-stage, push-pull AGC amplifier—is flat within ±0.5 db at full sweep width up to 800 MCS and ±1.5 db from 800 MCS to 1200 MCS. When using sweep widths as narrow as 20 MCS flatness at any center frequency is approximately ±0.15 db. **$1260.00**

- **HIGH OUTPUT!** .25 volt RMS on VHF— .5 volt RMS on UHF!
- **WIDE SWEEP WIDTHS!** From 100 KC up to 400 MCS!
- **FLAT OUTPUT!** Flat to ±.5 db on *widest* sweep width!

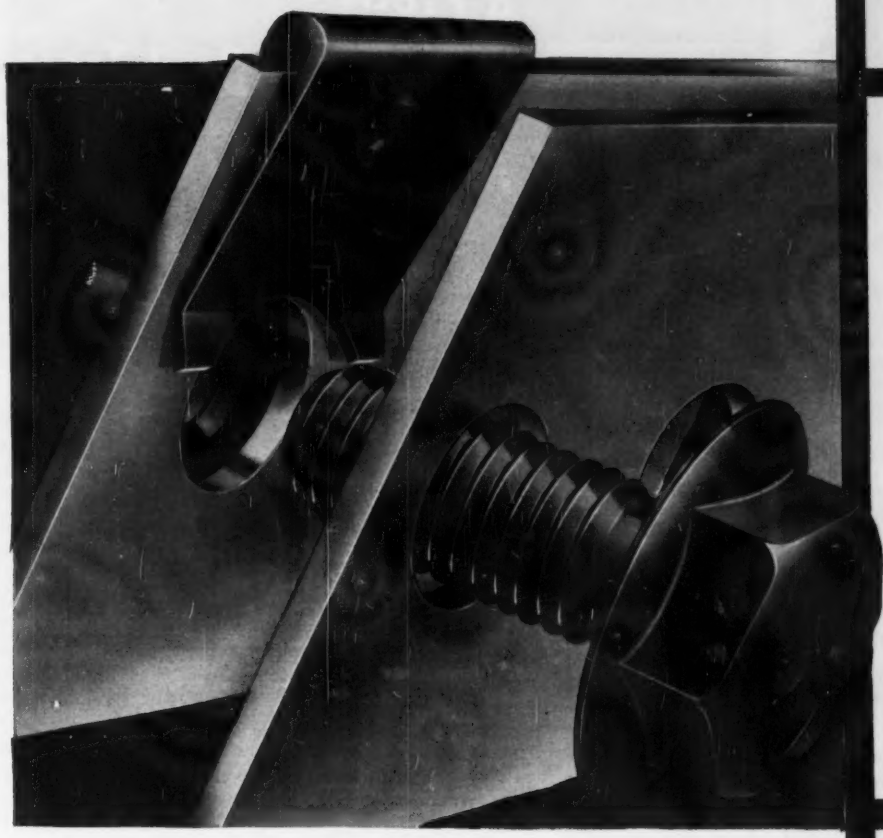
MODEL 900A IS NOW IN QUANTITY PRODUCTION!

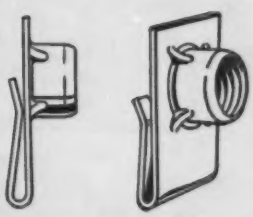
Write today for on the spot demonstration of this versatile instrument!

JERROLD **ELECTRONICS CORPORATION** *Industrial Products Division*

Dept. TED 30, The Jerrold Building Philadelphia 32, Pa.

DOT makes J NUTS with a difference





- FLUSH SEATING
- SELF-RETAINING
- SELF-TENSIONING
- LOW COST
- CAREFUL WORKMANSHIP

It takes a little extra care in the drawing operation to make really reliable J-nuts in volume but it's well worth the trouble. It reduces internal strains in the barrel so that DOT J-nuts stand up to working loads considerably better than the average fastener of similar construction.

Available in three thread sizes (5/16"-18 and 24, 1/4-20) and to fit three ranges of material thickness (.030" to .065"), DOT J-nuts are made of carbon steel. They hold themselves in place over stamped holes so that preassembly is practical in cases where the actual bolting operation comes at the end of a series of other operations.

Full details on request.

CARR FASTENER COMPANY

Division of United-Carr Fastener Corporation, Cambridge 42, Mass.

MAKERS OF DOT FASTENERS

AT LAST!
A Precision 200 KC Scope with Dual Trace Presentation!

NEW MODEL 122A

Here at last is a 200 KC oscilloscope—priced at just $625—giving you "big-scope" versatility and the time-saving convenience of simultaneous two-phenomena presentation.

Engineered to speed industrial, mechanical, medical and geophysical measurements in the 200 KC range, the new hp 122A has two identical vertical amplifiers and a vertical function selector.

The amplifiers may be operated independently, differentially on all ranges, alternately on successive sweeps, or chopped at a 40 KC rate.

Other significant features include universal optimum automatic triggering, high maximum sensitivity of 10 mv/cm, 15 calibrated sweeps with vernier, sweep accuracy of ±5% and a "times-5" expansion giving maximum speed of 1 μsec/cm on the 5 μsec/cm range. Trace normally runs free, syncing automatically on 0.5 cm vertical deflection, but a knob adjustment eliminates free-run and sets trigger level as desired between −10 and +10 volts. Rack or cabinet mount; *rack mount model only 7" high.*

For complete details, write or call your hp representative, or write direct.

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5140A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.
CABLE "HEWPACK" • DAVENPORT 5-4451
FIELD REPRESENTATIVES IN ALL PRINCIPAL AREAS

BRIEF SPECIFICATIONS hp 122A

Sweep: 15 calibrated sweeps, 1-2-5 sequence, 5 μsec/cm to 0.2 sec/cm, accuracy ±5%. "Times-5" expander, all ranges. Vernier extends 0.2 sec/cm range to 0.5 sec/cm.

Trigger selector: Internal + or −, external or line. Triggers automatically on 0.5 cm internal or 2.5 v peak external. Displays base line in absence of signal. Trigger level selection −10 to +10 v available when automatic trigger defeated.

Vertical Amplifiers: Identical A and B amplifiers, 4 calibrated sensitivities of 10 mv/cm, 100 mv/cm, 1 v/cm and 10 v/cm; ±5% accuracy. Vernier 10 to 1.

Balanced (differential) input available on all input ranges. With dual trace, balanced input on 10 mv/cm range. Input impedance 1 megohm with less than 60 μμf shunt. Bandwidth DC to 200 KC or 2 cps to 200 KC when AC coupled. Internal amplitude calibrator provided.

Function Selector: A only, B only, B-A, Alternate and Chopped (at approx. 40 KC).

Horizontal Amplifier: 3 calibrated sensitivities, 0.1 v/cm, 1 v/cm, 10 v/cm. Accuracy ±5%. Vernier 10 to 1.

Bandwidth DC to 200 KC or 2 cps to 200 KC, AC coupled.

General: 5AQP1 CRT, intensity modulation terminals at rear, power input approximately 150 watts, all DC power supplies regulated.

Price: (Cabinet or rack mount) $625.00.

Data subject to change without notice. Prices f.o.b. factory.

hp now offers 8 different precision scopes

New Spectrum Study Urged

There's also new interest in f-m radio, private microwave, video tape, station automation

CHICAGO—Broadcasters this week are evaluating the recently concluded 37th annual convention of the National Association of Broadcasters held here.

Some say the most important aspect of the convention was the attention focused on possible spectrum reallocation.

Representative W. G. Bray (R-Ind.) explained a resolution he recently introduced in Congress. It would set up a commission of non-government experts to study government spectrum use.

J. S. Patterson, deputy director of the Office of Civil and Defense Mobilization, agreed with Bray that a spectrum study should be conducted, and told broadcasters that no military group was demanding tv channels 2 to 6.

What Broadcasters Say

NAB vice president J. F. Meagher told the group that as of March 1 of this year, 725 commercial f-m stations were authorized, with 591 of these now in operation. One year ago the totals were 604 authorizations with 540 in operation. There are now 15 million f-m receivers in use in the U. S.

One broadcaster, M. H. Hanna, WHCU, Ithaca, N. Y., said there was no future for f-m radio unless it can be made a mass communication medium. He proposed all radio should be f-m rather than a-m.

A newly-formed group, the F-M Association of Broadcasters, formerly the F-M Development Association, has emerged from the convention. To date, no comment from FMAB has been made regarding opinion that all radio should be f-m, but remarks on this viewpoint may be forthcoming later on this year.

Private Microwave Links

A spokesman for the Jefferson Standard Broadcasting Co., Charlotte, N. C., described the successful operation of a private microwave link between station WBTV in Charlotte and station WBTW in Florence, S. C. Private links for broadcasters were approved by FCC late last summer.

The two stations are now able to combine talent and other facilities for more effective programming despite the 94 miles separating them. Broadcaster interest in the private link may point the way to construction of similar installations later in the year.

Equipment advances attracted a measure of attention, with standardization of recording playback heads for video tape machines emerging as one of the most salient steps forward.

The manager of station WJBK-TV, Detroit, cautioned equipment panelists against concluding that taped tv would be the answer to daily aches and pains. Another panelist reported several Hollywood companies are planning to get into video tape syndication.

Ampex spokesmen described improvements and accessories made for their recorders, including a timer which measures tape runs to an accuracy of 0.0014 percent, and a cue track for voice recording.

A new tape recorder for video was introduced by Radio Corporation of America. Company spokesmen pointed out it was compatible with "any standard recorder." It also lets the broadcaster start with a monochrome unit and include color modules later.

Transistor TV Set

Japanese portable tv set using 32 transistors is going into trial manufacture at Tokyo Shibaura Electric. Eight in. screen set operates on 30 watts from two batteries of 22 and 6 volts, weighs 32 lb and is 12 x 17 x 11 in.

Printed Circuit Reliability through Quality Control

If your printed circuit is vital to the flight of a guided missile it must not fail. It may even undergo a 100% inspection at every stage of manufacture.

Bureau quality control is more than a method of inspection. It is also a check on the causes of rejects to weed them out. Our production techniques eliminate even "acceptable" flaws because we are striving to produce *perfect* boards. This is why Bureau circuits, whether tested 100% or on a scientific-sample basis, are consistently better than statistics predict. To put reliable circuits into your product, investigate the Industrial Division of the Bureau of Engraving, Inc.

The Bureau of Engraving, Inc., QUALITY CONTROL MANUAL FOR PRINTED CIRCUIT BOARDS AND BOARD ASSEMBLIES is approved for the U. S. Air Force. We have a limited surplus of these manuals which we will send to qualified persons on request . . . write today.

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Interior view of tracked vehicle above

Kleinschmidt teletypewriters maintain constant contact, in print, between U. S. Army command and field positions

On the go...bouncing over bunker or beachhead ...Kleinschmidt teletypewriters accurately, efficiently send and receive printed messages. Developed in cooperation with the U. S. Army Signal Corps, these units instantly provide both sender and receiver with identical data...*printed on paper!* In recognition of its quality, Kleinschmidt equipment is manufactured for the U. S. Army under the Reduced Inspection Quality Assurance Plan. This kind of proved experience is now available for unlimited advances in electronic communications for business and industry.

KLEINSCHMIDT

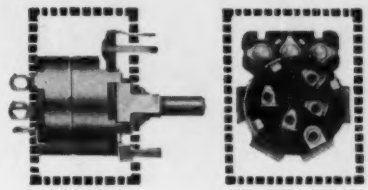
DIVISION OF SMITH-CORONA MARCHANT INC., DEERFIELD, ILLINOIS

Pioneer in teleprinted communications systems and equipment since 1911

WHEN IT COMES TO MINIATURE CONTROLS...

CHECK THE OVERALL SIZE...

including switch, if needed. For practical space-saving ability, Stackpole miniature "F" Controls lead the way — only 0.637" in diameter behind the panel for the entire length of *both* control and switch.



Photos show side and rear views of a Stackpole F Control with 2-pole switch. Dotted lines indicate behind-panel space occupied by a conventional "miniature" control.

Notice how Stackpole's small switch size perfectly complements the miniature control . . . saves precious chassis space where it's needed the most.

FEEL and HEAR THE SWITCH ACTION...

for the tease-proof, positive "feel" and audible "click" only a true snap-action switch provides. "B"–Series switches used on "F" Controls have the same time-proven mechanism as larger Stackpole control switches. They're U.L. Inspected for 1 amp. @ 125v ac-dc; 4 amps @ 25v dc.

CHECK THE COMPLETENESS OF BOTH CONTROL and SWITCH LINES

Printed wiring, wire-wrap, or standard lug terminals as well as fold-tab or threaded bushing mountings are available on all Stackpole miniature "F" controls. *Both* SPST and DPST switches can be supplied.

STACKPOLE

miniature "F"-series

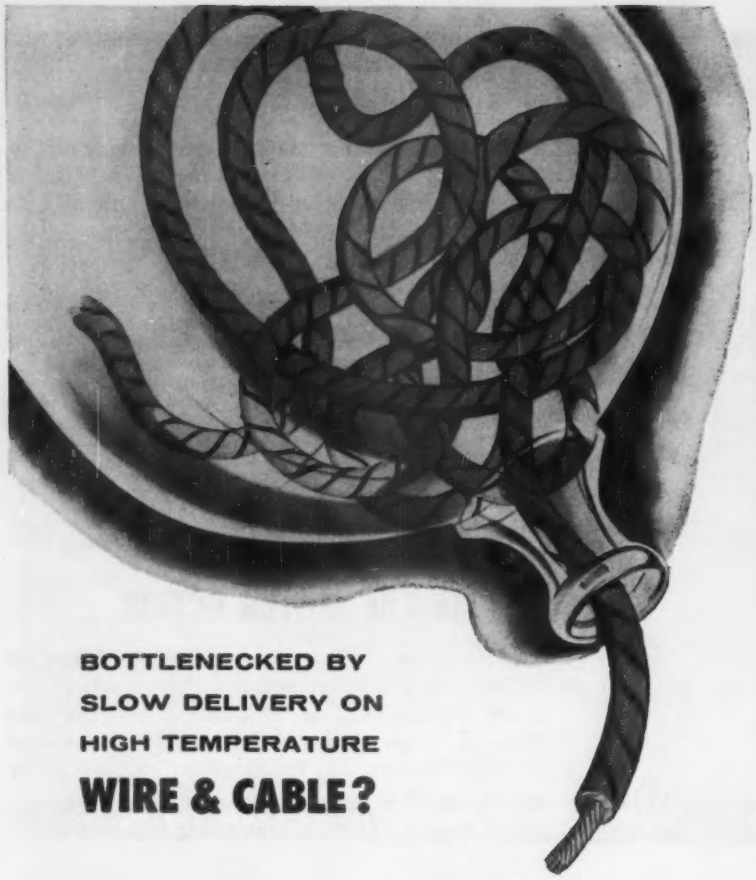
VARIABLE RESISTORS

Electronic Components Division

STACKPOLE CARBON COMPANY, *St. Marys, Pa.*

In Canada: Canadian Stackpole Ltd., 550 Evans Ave., Etobicoke, Toronto 14, Ont.

FIXED & VARIABLE COMPOSITION RESISTORS • SLIDE & SNAP SWITCHES • IRON CORES • CERAMIC MAGNETS
FIXED COMPOSITION CAPACITORS • CERAMAG® FERROMAGNETIC CORES
HUNDREDS OF CARBON, GRAPHITE, AND METAL POWDER PRODUCTS.



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Fastest delivery . . . highest quality . . . optimum reliability . . . these are the qualities that make Super-Temp's TEFLON* insulated, high temperature wires first choice *all the time.* Super-Temp has the right wire, cable or tubing, designed for specific applications, or can fabricate them to your particular requirement.

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Agents in principal electronic manufacturing areas

*DuPont's TFE Resin

MEETINGS AHEAD

Apr. 12-19: Aircraft and Space Communications, World Congress of Flight, Air Force Assoc., EIA, Las Vegas, Nev.

Apr. 13-15: Protective Relay Conf., A & M College of Texas, College Station, Tex.

Apr. 14-15: Industrial Instrumentation & Control Conf., PGIE of IRE, Armour Research Foundation, Illinois Inst. of Tech., Chicago.

Apr. 16-18: Southwestern IRE Conf. and Electronics Show, SWIRECO, Dallas Memorial Aud. and Baker Hotel, Dallas.

Apr. 20-21: Analog & Digital Recording & Controlling Instrumentation, AIEE, PGIE & PGI of IRE, Bellevue-Stratford Hotel, Phildelphia.

Apr. 20-22: Instrument Society of America, Southeastern Conf. & Exhibit, Gatlinburg, Tenn.

Apr. 20-22: Man-in-Space Conf., American Rocket Society, Hotel Chamberlain, Hampton, Va.

Apr. 21-22: Electronic Data Processing, IRE Section, Engineering Society Building, Cincinnati, O.

Apr. 22: Medical Electronics, The Electro-Medical Program at the Moore School, PGME of IRE, Univ. of Penn., Philadelphia.

Apr. 28-30: Power Sources Conference, USA Signal Research & Devel. Lab, Fort Monmouth, Shelburne Hotel, Atlantic City, N. J.

Apr. 30-May 1: Controllable Satellites Conf., ARS, M.I.T., Cambridge, Mass.

May 3-7: Electrochemical Society, 115th Annual Meeting, Hotel Sheraton, Philadelphia.

May 4-6: Aeronautical Electronics, National Conf., PGANE of IRE, Biltmore Hotel, Dayton, O.

May 4-7: Instrumentation Flight Test Symposium, ISA, Seattle, Wash.

May 4-8: Society of Motion Picture & Television Engineers, Annual Convention, Fontainebleau Hotel, Miami Beach, Fla.

May 5-7: USA National Committee, URSI, PGAP, PGCT of IRE, Willard Hotel, Wash., D. C.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 90.

GENERAL INSTRUMENT SEMICONDUCTOR DIVISION

Radio Receptor / *silicon diodes*

IN ANY COMBINATION OF CHARACTERISTICS

high speed • high conductance • high temperature
high voltage • high back resistance

General Instrument semiconductor engineering has made possible these Radio Receptor diodes with a range of characteristics never before available to the industry.

The types listed here are just a small sampling of the complete line which can be supplied in volume quantities for prompt delivery. Write today for full information.

Including the industry's most versatile diode with uniform excellence in all parameters **1N658**

GENERAL PURPOSE TYPES		FAST RECOVERY TYPES	HIGH CONDUCTANCE TYPES	
1N456	1N461	1N625	1N482	1N484A
1N457*	1N462	1N626	1N482A	1N484B
1N458*	1N463	1N627	1N482B	1N485
1N459*	1N464	1N628	1N483	1N485A
		1N629	1N483A	1N485B
			1N483B	1N486
			1N484	1N486A

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Depreciation Reform—

Why Industry Needs A Modern Tax Policy

A shockingly large proportion of our industrial plant and equipment is obsolete. As indicated by an earlier editorial in this series, over $95 billion would have to be spent —and spent soon—to bring our industrial facilities up to the best modern standards. Yet plans for 1959 call for little more than $30 billion of actual spending—barely enough to make a start on this backlog of modernization.

At the heart of the problem of obsolescence is a federal tax policy that discourages business from replacing inefficient facilities. It is the purpose of this editorial to spell out a tax reform Congress can make this year—with little cost in terms of tax revenue—that would go a long way toward removing the barrier to modernization of plant and equipment. This reform is a more realistic system of tax deductions for depreciation and obsolescence of productive facilities.

A Barrier to Modernization

Industry abounds with examples of old and obsolete facilities—despite large expenditures made in the past few years. Two-thirds of our metalworking equipment is over ten years old. Over half the capacity of our chemical process industries was installed before December 1950. Only a minor fraction of our railroad freight moves in new freight cars or the new push-button freight yards.

The tax law bears a large part of the responsibility for this lag in modernization because of its important influence on business investment in plant and equipment. For many years the tax law has permitted as a deduction from income "a reasonable allowance" for wear and tear and obsolescence of productive facilities. These annual deductions affect business investment in several ways.

- They are the way a company recovers its investment in plant and equipment.
- They determine in large measure, the amounts of money that are spent each year to replace and modernize facilities.
- Furthermore, the schedule for depreciation often determines **when** a specific machine or building is actually replaced.

The law requires that depreciation deductions be spread over the "useful life" of a building or machine. But the periods of useful life for tax purposes today still depend heavily upon tables drawn up by the Treasury almost 20 years ago. These tables reflect the replacement practices of depression years. Also, they were compiled at a time when the pace of technological progress in industry was much slower than it is now. **For nearly all types of equipment the indicated period of useful life is longer —sometimes much longer—than most experts consider realistic at today's rate of technological advance.**

The result of these outmoded depreciation schedules is that the recovery of investment is dragged out, and the replacement of obsolete equipment is delayed.

In The Right Direction

Congress should establish, by law, the right to use shorter depreciation periods on productive equipment. It should do so in a way that would free industry from obsolete concepts of the rate of technological change and would provide incentives to install new equipment and produce new products.

The tax reform act of 1954 made some progress in this direction—but not enough. It introduced new methods for calculating depreciation —the declining balance and the sum-of-the-years' digits—which enable a business to recover most of the investment in a new facility in the early years of its useful life. However, these new methods do not accomplish their desired purpose when the supposed "useful life" is still an unrealistically long period of years.

Industry is by no means free from blame for the failure to bring depreciation policy into line with the needs of a modern, growing economy. According to Joel Barlow, president of the Tax Institute, "management has largely ignored the Commissioner's invitation . . . to come into the Internal Revenue Service office and make a case for shorter depreciable lives by establishing technological obsolescence."

The failure of many companies to see their own interest in more realistic depreciation not only holds them back from modernizing their own facilities but also lends support to the Treasury in its continued adherence to an outdated policy.

A Suggestion For Reform

An excellent model for reform of the depreciation policy in our tax law is the system used successfully in Canada for a decade. In Canada, all productive equipment may be depreciated at relatively fast rates assigned to each of 14 broad categories. The Canadian system permits depreciation up to twice as fast as the antiquated tables of useful lives now followed in the U. S. It also gives the individual business far greater flexibility in determining depreciation schedules that fit its own needs and experience.

For example, in the category or "bracket" covering general machinery a taxpayer in Canada may depreciate up to 20% of the machine's value annually, on a declining balance basis. In the U. S. the fastest rate at which many types of machinery can be depreciated is only 10%. In other categories, from tools and dies to buildings and pipelines, the Canadian system also allows faster depreciation and provides greater incentive to invest in new facilities.

The cost of this reform in terms of lower tax revenue would be small—probably less than $500 million in the first year. And even this would merely be postponed, not permanently lost. Indeed, there is a very good prospect that tax revenue would not suffer at all. The increase in spending for new plant and equipment resulting from this tax reform would mean an increase in wages and profits—and therefore in taxes—in industries that produce machinery and other capital goods.

A realistic tax policy on depreciation would provide a badly needed incentive for industry to replace obsolete and inefficient facilities with up-to-date plants and equipment. It would step up our rate of technical advance and economic progress. And it would put U. S. industry in better shape to meet the growing competition from other countries that have grasped the advantages of fully modern technology.

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Donald C. McGraw

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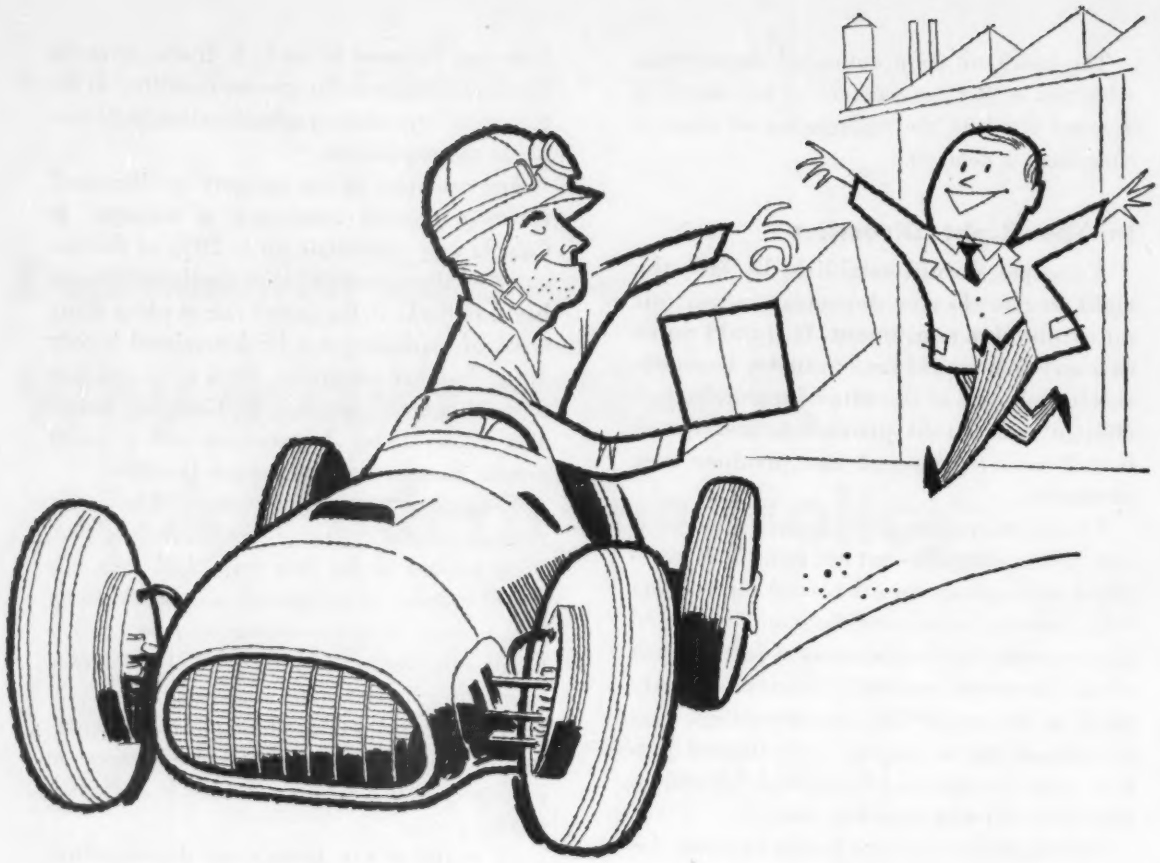

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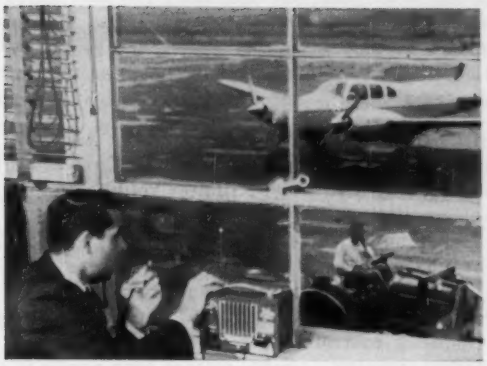


Class D units may be used extensively at airports

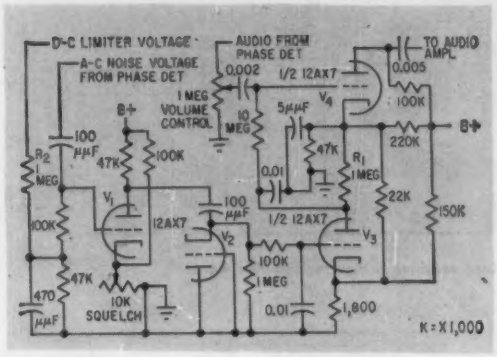


FIG. 1—Squelch circuit for reducing noise interference

Citizens Radio Revision Spurs Equipment Design

Recent revision of citizens radio service frequency allocations now permits four classes of stations. Old ham 11-meter band is now available. Brief synopsis of commercially available equipment is tabulated and special attention is given to new noise silencer, squelch and selective-signaling circuits

By **LEO G. SANDS,** Consultant, Ridgewood, N. J.

RECENT REVISION of FCC rules governing Citizens Radio Service has spurred development of new equipment. This article describes commercially available equipment designed to use the revised frequencies.

CLASSES OF STATIONS—Class-A stations may be operated between 460.05 and 460.95 mc or between 462.55 and 466.45 mc using either a-m or f-m modulation at a maximum power input of 60 watts to the final amplifier. No restrictions on antenna systems have been imposed except in regard to safety of aircraft.

Class-B stations may be operated only on 465 mc using either a-m or f-m modulation with up to 5 watts input to the final amplifier.

Class-C stations may be operated for control purposes only (model aircraft or boats, garage doors, etc.) on 26.995, 27.045, 27.095, 27.145, 27.195 and 27.255 mc with all frequencies crystal controlled. Power input to the final amplifier is limited to 5 watts except stations using 27.255 mc may use up to 30 watts input. This latter frequency is available on a shared basis with other services including medical electronics.

Class-D stations may be operated between 26.965 mc and 27.225 mc using a-m modulation only. Power input to the final amplifier is limited to 5 watts, and the transmitters must be crystal controlled.

Table I lists typical commercially available equipment for these new citizen bands.

CLASS-A EQUIPMENT — Several manufacturers build f-m mobile units for operation between 450 and 470 mc to specifications that meet the requirements of the industrial, public safety, and land transportation services. The same equipment may be used in class-A citizens radio applications even though the technical standards are not as rigid.

One of the available receivers for class A use employs triple conversion. Two r-f stages precede the first mixer. The 50-mc i-f is amplified and passed to the second mixer whose 10-mc i-f is ampli-

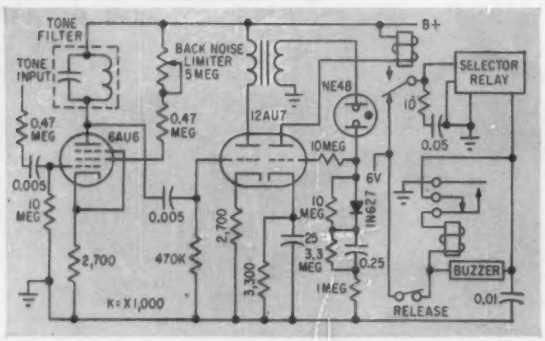


FIG. 2—Tone sensitive device for selective signaling

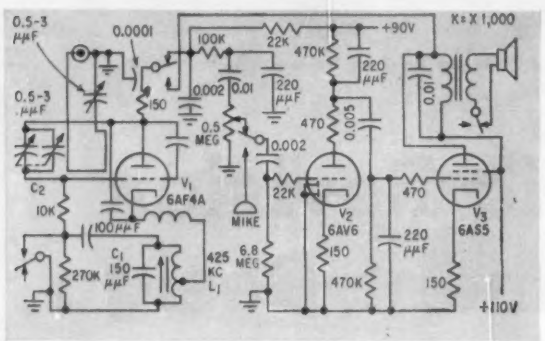


FIG. 3—Typical class-B transceiver

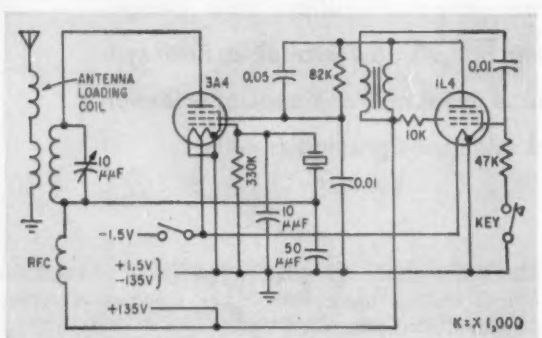


FIG. 4—Tone-modulated control transmitter

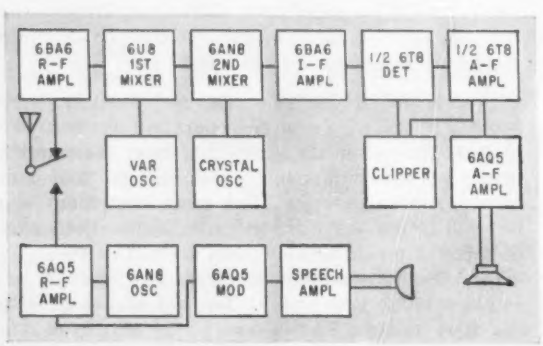


FIG. 5—Typical class-D unit tube layout

fied and supplied to the third mixer. The output of the third mixer is a 1,500-kc i-f signal. Ahead of the two-stage 1,500-kc i-f amplifier is an interchangeable filter; one providing 100 db attenuation at ±100 kc and the other providing the same attenuation at ±50 kc. Two limiter stages follow the 1,500-kc i-f amplifier. A phase detector rather than the usual discriminator is used.

SQUELCH CIRCUIT—The receiver employs the squelch circuit shown in Fig. 1. This circuit is actuated by both the d-c limiter voltage and the a-c noise voltage.

When no signal is present, the noise voltage from the phase detector is amplified by noise amplifier V_1. The amplified signal is converted into a positive voltage by noise rectifier V_2 and is applied to the grid of squelch control tube V_3. This action allows V_3 to conduct, causing a sizable voltage drop across R_1 that makes the grid of V_4 considerably more negative with respect to its cathode.

When a signal is received, two things happen: the gain of noise amplifier tube V_1 is reduced by the increased negative limiter voltage applied to its grid through R_2; the a-c noise voltage drops as a result of the quieting action of the receiver. Thus, the positive voltage applied to the grid of V_3 is smaller reducing its plate current and thus the voltage drop across R_1. This causes a reduction of the negative voltage on the grid of V_4. Audio amplifier V_4 is now active and allows audio signals to get through.

CLASS A STATION ACCESSORIES—Among the newer developments is a uhf preamplifier used to increase receiver sensitivity to make up for transmission-line losses. Inserted between the antenna and the receiver, up to 6-db gain may be realized. This is one way of getting increased range when transmitters are already being operated at maximum allowable limits.

Due to congested band conditions, means for preventing reception from unwanted stations has resulted in development of tone-operated squelch systems. In these systems, the squelch is kept closed unless the r-f signal is accompanied by a distinguishing audio tone that is filtered out in the receiver. Thus, all mobile units in a fleet need hear only their associated base station.

Another expanding use for selective signaling is the muting of base station receivers and remote control units until called by a mobile unit. Each base station or control point is signaled only in response to dialing its individual number. Several telephone companies are installing mobile dial telephones.

DECODER UNIT—Figure 2 is a schematic of a decoder unit that responds to digital tone pulses fed to it from a radio receiver. The pulses, produced by a telephone dial, are decoded by a selective electromagnetic switch.

The decoder circuit is designed to reject noise impulses and functions even when noise is stronger than the desired single-tone signal. The decoder responds to breaks in the tone caused by interruption

of a tone generator at the transmitter by the normally closed pulsing contacts of a telephone dial.

CLASS-B EQUIPMENT—Typical of the class-B equipment is the transceiver whose schematic is shown in Fig. 3. A 6AF4 tube, V_1, serves as a self-excited power oscillator when transmitting and a superregenerative r-f amplifier when receiving. Tube V_2 serves as the a-m modulator when transmitting and as the audio power amplifier during reception. Tube V_2 doubles as first audio stage for the receiver and as the transmitter speech amplifier.

The receiver quench oscillator, tuned by L_1 and C_{1_1}, is disabled by a pair of switch contacts when transmitting. Tuning is accomplished by bending one of the plates of C_2 at one end of the tuned line. The plate is slotted to form a large and a small section. The small section permits fine adjustment of frequency.

CLASS-C EQUIPMENT—Previously, only 27.255 mc was available for control purposes. Now that the FCC has made five new control channels available, the service will be more useful to hobbyists and others who employ radio for remote control of model aircraft or boats, and garage doors.

The transmitting equipment is usually simple. The control signal may be tone-modulated a-m and a number of different tones may be used to enable control of several functions using one frequency. A typical tone-control transmitter is shown in Fig. 4. This unit uses filament type tubes and receives power from self-contained A and B batteries. Receivers used on model planes are usually transistorized.

Table I—Typical Commercially Available Equipment for new Citizens Bands

Mfr and Model	Class	Power Consumption Re-ceive	Trans-mit	Power Output	Features
Bendix 2V13E	A	112 w	225 w	10–12 w	Used in general mobile service
Kaar Eng. Corp. TR500	A	70 w	105 w	4–5 w	Triple conversion superhet
Secode RPD-634	A	...	...	...	Decoder, accessory
Vocaline Corp. JRC400–JRC425	B	18 w	18 w	...	JRC425 has mike push-to-talk. JRC400 has manual panel switch
CG Electronics Corp. T-12	C	...	...	...	Tone control transmitter
Int. Crystal Mfg. Corp. CTZ-5	D	...	...	...	Double conversion superhet
Morrow Radio Mfg. Corp. Moradio Trans-Receiver	D	...	...	...	Double conversion superhet
Kaar TR325	D	3.3 amp	6/12 v	...	Double conversion superhet
Telebeam Ind. Magic Wand	D	...	...	...	Top of vehicle mounted, 24-inches long

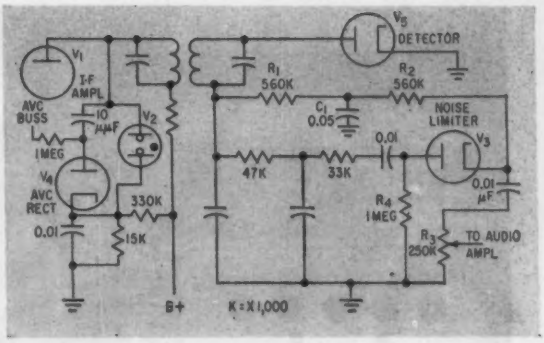


FIG. 6—Noise limiter for ignition interference

CLASS-D EQUIPMENT—Several manufacturers are building radiotelephones for use in this new band. A typical unit is shown in the block diagram of Fig. 5. The receiver is a double-conversion superdyne type.

A noise limiter is almost essential in a 27-mc a-m receiver, particularly if used in or about motor vehicles, because of ignition interference. A two-step noise silencing system is shown in Fig. 6.

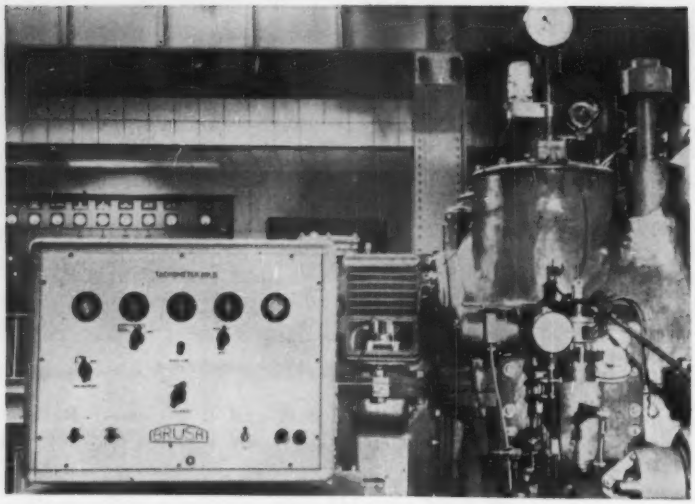
High amplitude pulses are clipped at the plate of the last i-f amplifier V_1 by NE-2 neon tube V_2 which fires momentarily and shunts the plate load of V_1. Diode V_3 serves as an electronic switch and opens the audio circuit momentarily when noise pulses are received. This action occurs for such a short duration that audio distortion is avoided.

Diode V_3 is in series with the signal path to the first audio amplifier. Under normal conditions, the cathode of V_3 is slightly more negative than its plate because it is connected through R_1 and R_2 to a more negative point on the diode load. When the diode conducts, it appears as a closed switch. The audio signal developed across volume control R_3 is approximately the same as that across R_4.

When a large noise pulse is received, the plate of V_3 swings more negative than its cathode due to the time delay caused by the R-C network R_1 and C_1. This cuts off diode V_3 which now appears as an open switch preventing the noise pulse, as well as the audio signal, from reaching volume control R_3. The circuit recovers quickly and the cathode of V_3 again becomes more negative than its plate and becomes a closed switch allowing audio signals to pass.

ANTENNAS—For class-B equipment, the usual transceiver antenna is a 6-in. vertical rod that plugs into a receptacle mounted to the top of the metal cabinet. A ground-plane antenna is often used and for point-to-point communication, corner reflector antennas affording up to 10 db forward gain are sometimes used.

For class-D equipment, a base-loaded whip antenna less than 24-in. long has been developed. While not as efficient as a full quarter-wave whip, the actual results are generally satisfactory.



Tachometer measures rotation speed of turbine in series of tests following installation of turbine in power station

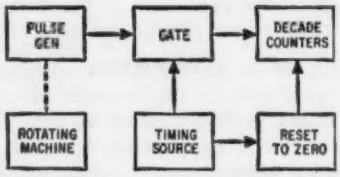


FIG. 1—Tachometer system counts pulses produced during a fixed time interval by pulse generator connected directly to rotating machine

Digital Tachometer Aids

DESIGN AND DEVELOPMENT of steam turbines requires accurate measurement of the rotational speed of the blading system. Vibrations set up in individual blades and blade batches must be correlated with this rotational speed for detailed analysis.

Tachometer accuracies of at least 0.01 percent are required for these analyses. A block diagram of a tachometer system designed for this purpose is shown in Fig. 1.

The tachometer counts pulses from a pulse generator coupled directly to the rotating shaft. The pulses pass through a time-operated gate to a series of decade counters. The counters display the number of pulses passed through the gate in a precisely known time. After a suitable display time, the counters are returned to zero for the next count.

The most successful pulse generator used with the tachometer has a rotor and stator, each having 30 slots cut in the periphery. Thus, for one revolution of the rotor, 30 changes in capacitance are produced.

These capacitance changes are used to frequency modulate an oscillator. The resulting f-m signal is demodulated, and the 30 voltage pulses produced are fed to the tachometer circuits. By setting the gating time at 2 sec, a direct count in rpm is provided on the decade display.

The tachometer, shown in Fig. 2, uses digital techniques throughout. It was made as versatile as possible so that it could also be used as a general purpose frequency-measuring instrument. Therefore, a decade scaler was incorporated providing a second range 10 times the basic range.

The counting ranges are zero to 20,000 pps (zero to 40,000 rpm) and zero to 200,000 pps (zero to 400,000 rpm). Accuracy is better than 0.005 percent on both scales. This is equivalent to ±one pulse on the basic range and ±10 pulses on the scale-of-ten range.

Table I—Switching Sequence in Auto-Locking and Gating Unit

Tube	Initial State	After First Gate Pulse	After Second Gate Pulse	After 5, 10 or 15 sec	After 200 Millisec
V_{21}	On	Off	On	On	On
V_{22}	Off	On	Off	Off	Off
V_{27}	Off	On	Off	Off	Off
V_{23}	Off	Off	On	Off	Off
V_{24A}	On	On	Off	Off	On
V_{24B}	Off	Off	On	On	Off
V_{26A}	Off	Off	On	Off	Off
V_{26B}	On	On	Off	On	On
V_{25A}	Off	Off	Off	On	Off
V_{25B}	On	On	On	Off	On

Tachometer counts up to 400,000 rpm on two scales at an accuracy of 0.005 percent. Pulses generated by capacitor unit connected directly to rotating machine are passed through accurately controlled gate. By generating 30 pulses for each revolution and holding gate open for two minutes, direct indication in rpm is provided on counting tubes. Unit also provides one-minute gating period, and gate can be kept open for batch counting. Timing unit that controls gate can also be used as frequency standard

By JOHN K. GOODWIN,
Research Division, Brush Electrical Engineering Co. Ltd., East Leake, Loughborough, Leics, England

in Turbine Design

The instrument has two internal gating periods, one and two sec. Provision for external gating is also incorporated, enabling random pulses to be counted (such as in batch counting) to a maximum of 99,999 on the basic range.

Input and Limiting Stage

The voltage required at the input circuit shown in Fig. 3 is reasonably low so that the instrument will not normally require external preamplifiers. A minimum of 1.5 v peak-to-peak is required. Maximum voltage is about 10 v peak-to-peak.

Triode V_{1A} functions as a class-A amplifier. Resistor R_1 prevents the input circuit from being loaded should the tube be driven into grid current by excessive input voltage.

Output from V_{1A} is R-C coupled to V_{1B}, which operates as a cathode follower near cutoff. Positive-going output from cathode follower V_{1B} is fed to Schmitt trigger V_2. The Schmitt trigger produces rectangular pulses with a rise and decay time of approximately one μsec. These pulses are differentiated by capacitor C_1 and resistor R_2. The negative-going pulse is removed by the diode shunting R_2.

When using the basic counting range, the pulses are fed directly to the gating unit. However, when V_{1B} is connected to the scale-of-ten divider, output is applied to V_{3A} through C_2. The negative pulses trigger the Eccles-Jordan binary divider, V_3, and the positive pulses are removed by the coupling diodes.

Scale-of-Ten Divider

The divider consists of the four cascaded Eccles-Jordan binary dividers shown in Fig. 3. This arrangement would provide a division ratio of 16, but, by inserting suitable feedback loops, the division ratio is reduced to 10. The circuit operates up to 500 kc.

Thus the input and limiting stage and the scale-of-ten divider produce pulses corresponding to input or one-tenth input frequency.

The timing panel shown in Fig.

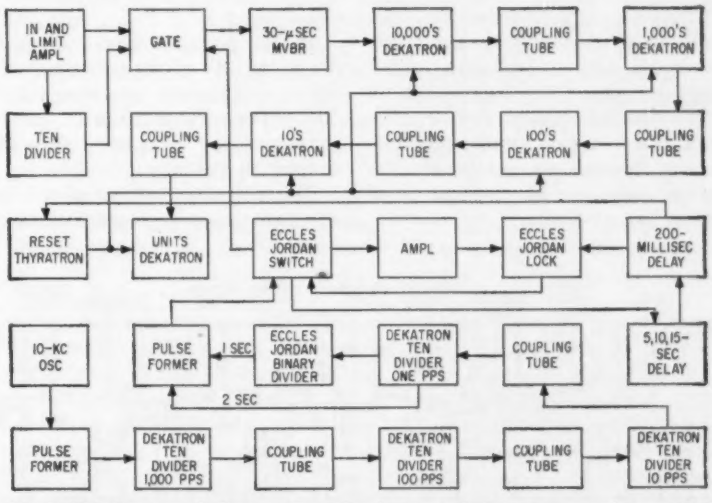


FIG. 2—Digital system displays number of pulses passed through accurately controlled gate in one or two-sec intervals to indicate shaft velocities to 40,000 rpm on basic scale or to 400,000 rpm using scale-of-ten divider

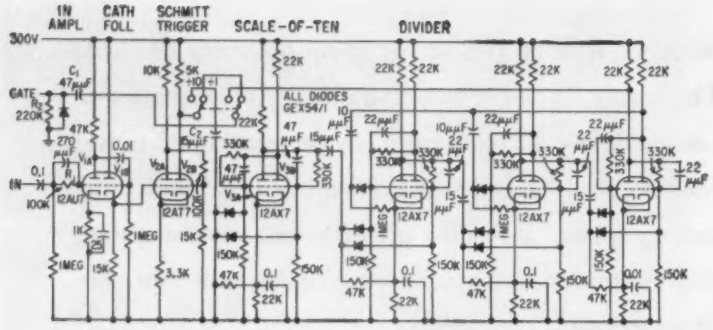


FIG. 3—Unit produces pulses at same or at one-tenth input frequency. Feedback loops are used in four cascaded binary dividers to get division by 10 rather than 16

4 provides accurate timing pulses for operating the gate. Accuracy of the whole instrument depends on this unit, and it must be highly reliable.

Pentode V_4 is used as a 10-kc crystal-controlled oscillator. It is operated at a low voltage (50 v) and has amplitude control to prevent the crystal being overdriven.

Oscillator output is fed through cathode follower V_{5A} to prevent loading the oscillator. This output is applied to amplifier V_{5B}, which is normally conducting heavily. Tube V_{6A}, which is normally cutoff, is caused to conduct by the positive pulses from V_{5B}.

The negative-going pulses from V_{6A} drive the first Dekatron divider, a high-speed type that divides 10,000 to 1,000 pps. Three miniature Dekatron tubes reduce the 1,000 pps to 100, 10 and one pps.

Pulses at a prf of one sec from the last divider (V_7) are fed either to a one-shot multivibrator pulse-forming stage (V_8) or through an Eccles-Jordan binary divider (V_9) and then to the multivibrator. Thus pulses of either one or two sec repetition frequency at constant pulse width are available.

This unit provides an accurate frequency standard that can be used for other purposes.

Display Unit

The display unit shown in Fig. 5 has five Dekatron tubes arranged in cascade. When the timing period is two sec, it is possible to count to 40,000. The limit is set by the maximum speed of the first Dekatron. Negative-going pulses from the plate of the gating tube are fed to a 30-μsec one-shot multivibrator, V_{10}.

The negative pulses from the plate of V_{10B} are fed to high-speed Dekatron V_{11}. Maximum operating frequency for this tube is 20,000 pps, which is equivalent to a period of 50 μsec. Therefore, pulse-forming multivibrator V_{10} must produce a pulse less than 50 μsec wide to secure reliable running at maximum speed.

Output from the final cathode of V_{11} is fed to triode-connected V_{12}, which is normally biased to cutoff. The −140-v pulses from V_{12} have a maximum prf of 2,000. They are coupled to Dekatron V_{13}.

This Dekatron is coupled by trigger tube V_{14} to a third Dekatron, V_{15}. The trigger tube is self-quenching and is extinguished after each input trigger pulse. The last two Dekatrons, V_{16} and V_{17}, are coupled by V_{18} and V_{19}.

To return the Dekatrons to zero at the end of each display period, the zero line must be made positive with respect to ground. The guide electrodes of the Dekatrons are all returned to a common zero line. By making this line positive, all the guide electrodes are made positive with respect to the final cathode, and the glow returns to these cathodes.

Tetrode thyratron V_{20} is normally biased to cutoff. A positive pulse from the auto-locking circuit causes it to conduct. Conduction discharges a large capacitor, C_4, in its plate circuit. A large current pulse flows through R_4, raising the zero line to about 100 v for about 20 millisec.

Auto-Locking and Gating Unit

The gating circuit passes pulses in a given time. After the counting period (one or two sec), the gate is closed and remains closed long enough for the display to be read. Then the Dekatrons are returned to zero for the next count. The switching sequence of the tubes in this unit is shown in Table I.

Switch S_1 in Fig. 6 selects either internal or external gating pulses. This switch can also lock the gate open, so that random pulses can be counted over an indefinite period.

Pentodes V_{21} and V_{22} are connected as an Eccles-Jordan trigger. With S_1 at the internal position, gating pulses coming from the timing unit are differentiated by C_5 in the timing unit and R_{53}. The diode shunting R_5 eliminates the positive pulses. Resistor R_6 is included to limit current through the diode during the positive portion of

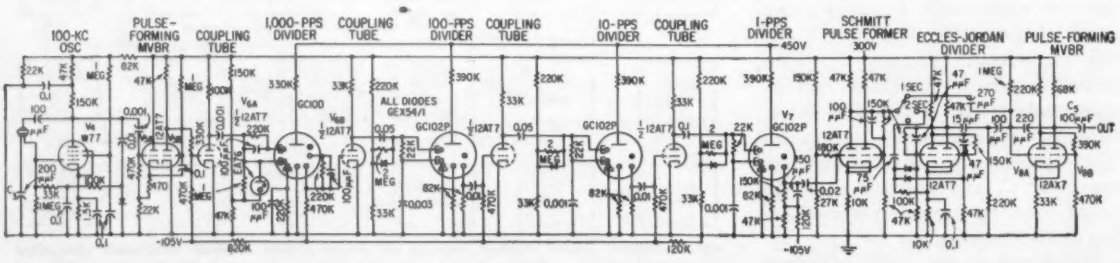


FIG. 4—Timing unit produces pulses at one or two sec intervals to control gate. Crystal oscillator produces 10-kc signal. Dekatrons are used to divide this to one pps output. A binary divider can reduce this to one pulse every two sec

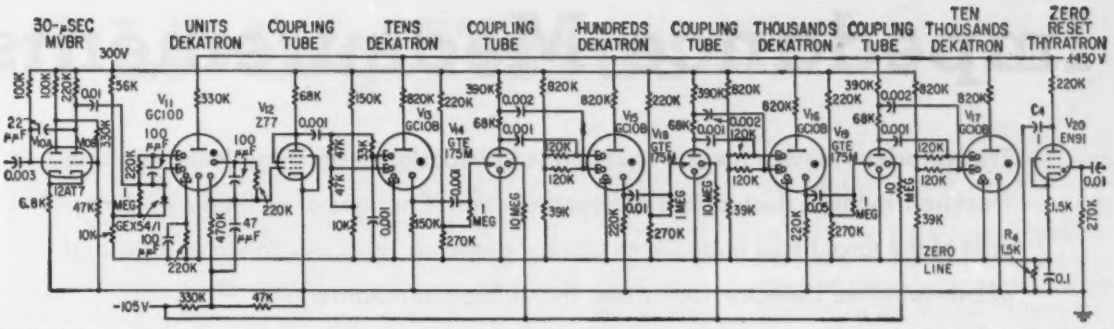


FIG. 5—Display unit indicates pulses passed by gate on Dekatron tubes. Tetrode thyratron returns Dekatrons to zero at end of counting period

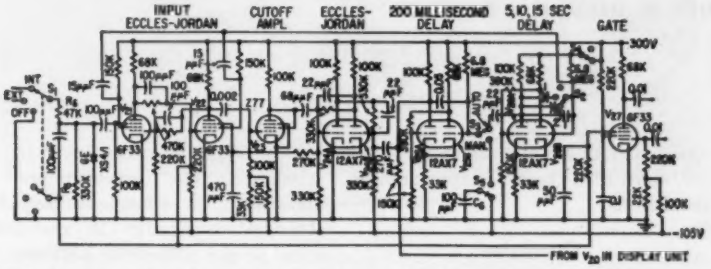


FIG. 6—Gate permits pulses to pass to display unit during gating period. Display can be retained for 5, 10 or 15 sec by switching in different capacitors in delay multivibrator. Additional 200-millisecond delay provides time for counting tubes to be returned to zero

the differentiated gating pulses.

Initially, V_{21} is conducting, developing a bias that is applied to the control grid of V_{22} and to the suppressor grid of V_{27}, the gate tube. The gating pulse switches V_{21} off and V_{22} on. This switching also removes the bias from the suppressor of V_{27}. At the end of the gating period, the second gating pulse switches V_{22} off and V_{21} on again.

Tube V_{28} is initially biased off and does not conduct until the second gating pulse. When V_{22} is cutoff by the second gating pulse, the control-grid potential on V_{28} is raised, permitting the tube to conduct.

Dual triode V_{24} is an Eccles-Jordan trigger with V_{24A} initially conducting. The drop in plate voltage on V_{28} is coupled to the control grid of V_{24A}, switching it off and switching V_{24B} on. In this state, a bias is coupled back to the suppressor of V_{22}, locking it off.

Dual triodes V_{25} and V_{26} form two one-shot multivibrators connected in series. A delay to permit reading the display is provided by V_{26}. Display time may be set at 5, 10 or 15 sec by switch S_2, to suit different operators and applications.

Actual delay depends on the interval between timing pulses. Multivibrator V_{26} is set for 3, 8 or 13 sec delay, so for a 2-sec timing period, actual display time is 5, 10 or 15 sec. For the one-sec period, the multivibrator is set for 4, 9 or 14 sec.

Push-button switch S_3 permits instantaneous counts. To use this switch, the delay circuit controlling display time is switched out of the circuit by S_{4}. Hence, the display remains after the count until the push button is pressed a second time. Then the display tubes are returned to zero, and a new count is taken automatically.

Tube V_{26B} is initially conducting. After the second gating pulse, when V_{24B} is switched on, V_{26B} is switched off. Tube V_{25A} conducts for the duration of the display.

Multivibrator V_{25} provides a 200-millisecond delay during which the Dekatrons in the display unit are returned to zero. When V_{26A} is switched off at the end of the display period, V_{25A} is switched on. This applies a trigger to the resetting thyratron in the display unit.

After the 200-millisecond period, V_{25B} is switched on again, returning V_{24} to its original state. With V_{24A} conducting again, the bias is removed from the suppressor of V_{28} for the next count.

Push-button switch S_3 normally connects C_3 to −105 v. After a manual count, S_3 is pressed. This applies the negative charge stored by C_3 to the control grid of V_{25B}, initiating the 200-millisec delay, and the Dekatrons are returned to zero.

Pentode Gate

Pentode V_{27} is used as the gating tube. The bias produced on the control grid of V_{22} is applied to the suppressor of V_{27}, keeping it cut off. When conduction is switched from V_{21} to V_{22}, this bias is removed, permitting the gate to pass pulses from either the input limiting amplifier or from the scale-of-ten divider.

Control-grid bias on V_{27} is kept at a level that prevents conduction except when pulses of relatively high amplitude are applied. This is done to prevent formation of a pedestal when suppressor grid bias is removed. It also suppresses spurious pulses from the scale-of-ten divider.

The spurious pulses are produced in suppressing the division ratio from 16 to 10 by the feedback loops. These spurious pulses are accentuated by the differentiating action of C_1 and R_2.

When the suppressor bias is removed, the grid signals are passed to the plate and to the display unit. After the timing period, V_{21} conducts again, and the control grid of V_{22} is biased to cutoff. The same bias is also applied to the suppressor of V_{27}, cutting off the gate. Pulses applied to its control grid are therefore blocked.

Impedance Measurements

Transistorized device measures changes in impedance of living tissue resulting from nonrhythmic fluctuations of blood content. Changes of as little as 0.1 percent of the total tissue impedance can be detected by a resistance bridge and phase-sensitive detector that scans the bridge unbalance

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RHYTHMIC FLUCTUATIONS of blood content cause body tissue during the cardiac cycle to expand or contract with consequent change in tissue impedance. A device which detects and records these impedance variations is known as a plethysmograph. The plethysmograph to be described will detect changes in blood volume caused by nonrhythmic smooth-muscle activity in the walls of the blood-vessels (vasoconstriction or dilation), as well as changes in extravascular fluid content and ionic changes of the tissue. These three causes of impedance change can be distinguished from one another only to the extent that their occurrence can be controlled under experimental conditions.

Operation

To measure impedance changes caused by vasomotor activity, a 50-kc signal is modulated by the unbalance of an impedance bridge. A pulsating unbalance results from the rhythmic changes in blood volume of the tissue being measured. These are the volume-pulse changes that coincide with the cardiac cycle.

However, nonpulsating change in resistance unbalances the bridge and requires a change in setting of the 25,000-ohm potentiometer for rebalance. The potentiometer is calibrated in ohms making the steady-state change in resistance equal to the difference between the new and previous potentiometer setting.

A schematic of the circuit is shown in Fig. 1. Transistor Q_1 in conjunction with T_0 constitutes an oscillator that generates approximately 50 kc. The output of T_0 is fed to emitter follower Q_2 which isolates the oscillator from the rest of the circuit.

Transformer T_1 supplies R_1, R_2, R_3, the 25,000-ohm potentiometer and the tissue segment which form a bridge circuit. The bridge permits measurement of resistances independently of the contact resistances. This is accomplished by using a four terminal connection, I_1 and I_2 to supply the current input and E_1 and E_2 to detect the voltage drop across the resistance being measured. The voltage drop across E_1 and E_2 is counteracted by the voltage from T_2 to form a null circuit.

The bridge also balances out noise fluctuations. The variation in impedance with the cardiac cycle is measured by the fluctuations it imparts to an electrical potential. Since the impedance fluctuations are generally less than 0.1 percent of the total impedance, their order of magnitude approaches the noise fluctuations in the voltage used to measure them. Use of the bridge to minimize noise insures that the modulation of the output of the

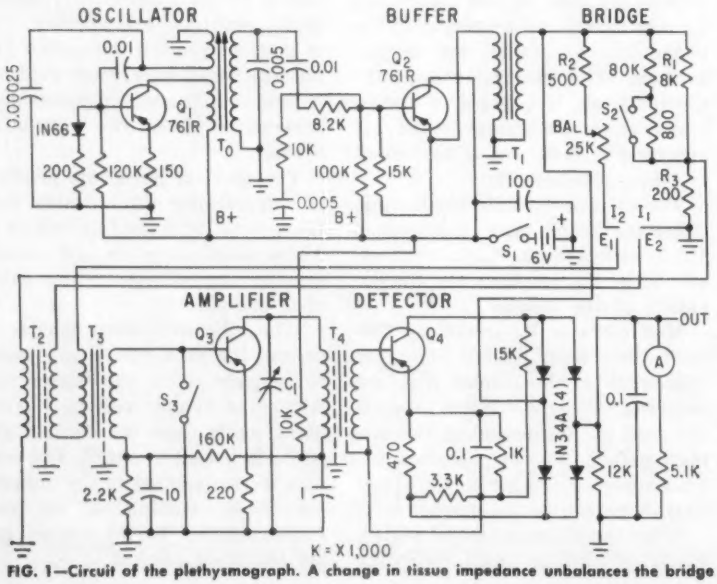
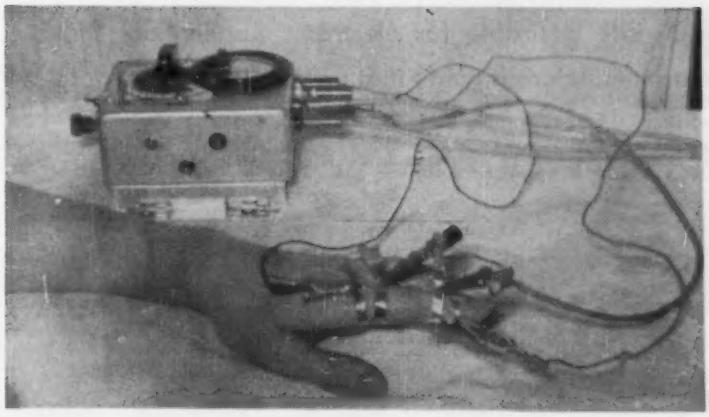


FIG. 1—Circuit of the plethysmograph. A change in tissue impedance unbalances the bridge

# of Living Tissue



Electrode arrangement for living tissue impedance measurement

bridge is basically due to the variations in the resistance of the tissue segment.

The voltage picked off across E_1 and E_2, which is the voltage drop across the tissue segment, is subtracted from the voltage drop across R_3 to establish the null. This is accomplished by the use of 1:1 coupling transformer T_2 which transfers the voltage drop across R_3 so it is in series and bucking the E_1-E_2 potential. Once the bridge is balanced any subsequent difference in potential is impressed across the high-impedance primary of T_3. The secondary of step-down transformer T_3 matches the input impedance of a grounded-emitter stage Q_3 while the primary presents a high impedance so that practically no current flows between points E_1 and E_2. Common-emitter amplifier Q_3 amplifies the unbalanced potential of the bridge. Impedance matching transformer T_4 couples the amplifier to a phase detector. Variable capacitor C_1, in conjunction with the core of T_3, adjusts the phase of the unbalanced bridge signal to a reference coming directly from the generator. Both signals feed the phase-sensitive detector. Closing switch S_2, after placing the electrodes and activating the circuit, eliminates any signal from the bridge and permits phase adjustment through T_3 so that the galvanometer reading is initially zero. It also permits a check on phase adjustment at any time during a recording session.

Determining Null

Since the instrument measures the pulsating variation of the absolute value of impedance, the bridge null adjustment is simplified by using a phase-sensitive detector to scan bridge unbalance. Therefore, small unbalanced quadrature components of the impedance do not affect the null of the detector and the null measuring circuit is relatively independent of small variations in phase. Thus the bridge can be balanced simply by the 25,000-ohm potentiometer.

In operation the vascular volume-pulse modulates the 50-kc signal so that the output of the bridge fluctuates on either side of a null. The phase detector demodulates the 50-kc unbalanced signal without distortion. This is true even when the bridge is so well balanced that the 50-kc carrier of the modulated signal coming from the bridge is completely eliminated and only the sidebands remain. The phase detector thus permits the use of a simple adjustment.

The unit is powered by four 1.5-v pencil batteries. Because of the low voltage and high frequency of the signal, switches with gold plated contacts are used.

In previous electrical impedance circuits the current was kept constant and the output of T_2 was balanced by a potentiometer against the potential detected along the segment of tissue being measured. In this circuit the voltage is held constant. The output of T_1 is in series with the potentiometer and the current output of T_1 is adjusted so that the voltage drop along the test segment is balanced. This modification is important because of the low-voltage power supply and the noise level of the transistors. If the voltage were allowed to vary in proportion to the impedance of the tissue the voltage drop could approach the upper limit of the batteries and the voltage drop could be so low that the noise level of the transistors would be reached.

Detection

The modulated signal due to the unbalance of the bridge is amplified and drives the base of the detector Q_4. The detector circuit is similar to one described in the literature.[1]

If the resistance of the tissue remains constant there is no pulsating or other unbalance of the bridge and the signal from the bridge is unmodulated or zero. Under these conditions the signal driving the base of Q_4 is the constant bias voltage derived from the voltage divider and filter capacitor in the emitter-collector circuit of Q_4. The resultant collector voltage is proportional only to the rectified reference signal, thus its adjacent half waves will have the same amplitude. As a result, the current on the a-c side of the rectifier will be a sinusoidal current without a d-c component, hence a d-c pulse will not be detected.

To obtain the d-c component, both sets of half waves pass through detector Q_4. Any alteration in the sensitivity of the detector cannot affect the balance.

REFERENCE

(1) S. Bagno and J. Fasal, Intruder Alarm Uses Phase-Sensitive Detector, p 106, ELECTRONICS, Feb. 14, 1958.

Selection Guide for

Silicone insulating materials are desirable for electronic applications that demand environmental extremes. Here is guide that presents significant data

By **C. G. CURRIN,** Project Leader, Electrical Laboratory, Dow Corning Corporation, Midland, Michigan

Table 1—Physical and Electrical Properties of Silicone Insulating Materials

Use	Silicone Insulation Available in the Following Form	Dielectric Properties: 60-cps Electric Strength in volts/mil[a]	Dielectric Properties: Vo. Resistivity, in ohm/cm Conditioned 48 hr/50/23 C	Dielectric Properties: Dielectric Constant[b]
Processing Materials				
Encapsulation and Filling	Room-temp.-vulcanizing silicone rubber	400	0.5×10^{14}	3
	Molded silicone rubber	400	5×10^{14}	3
	Filled solventless silicone resin	325	0.5×10^{14}	3.3
	Dimethyl Silicone Fluid, Electrical Grade	400	1×10^{14}	2.7
	Silicone Compound	500[c]	0.2×10^{16}	2.8
Winding and Coil Impregnation	Impregnating varnish	2,000[d]	1×10^{14}	3.1
	Solventless silicone resin	350	0.5×10^{16}	2.8
	Modified silicone resin	2,000[d]	1×10^{14}	3.2
Surface Coating	Silicone varnish	2,000[d]	1×10^{14}	2.7
	Silicone fluid	2,000[b]	1×10^{14}	2.7
Adhesives	Pressure-sensitive adhesive	600[d]	1×10^{14}	2.8
	Silicone rubber adhesive	400	0.2×10^{14}	2.9
Terminal, Connector Sealant	Room-temp.-vulcanizing silicone rubber	400	0.5×10^{14}	3
	Silicone compound	500[c]	0.2×10^{16}	2.8
Capacitor Impregnation	Silicone fluid, electrical grade	400	1×10^{14}	2.7
	Solventless silicone resin	350	0.5×10^{16}	2.8
Insulating Materials & Components				
Wire Insulation	Silicone modified wire enamel	3,000[d]	2×10^{14}	3.7
	Silicone bonded glass served wire	100	1×10^{14}	3.5
	Silicone rubber	400	1×10^{14}	3
Molded Parts	Resin molding compound	350	1×10^{14}	4.4
	Silicone rubber	400	5×10^{14}	3
Laminate (for terminal strips, coil forms, etc.)	Silicone-glass laminate	300	1×10^{14}	3.6
Varnished Glass Cloth	Silicone varnished glass cloth and sleeving	1,500[d]	1×10^{14}	3
Extruded Parts	Silicone rubber sleeving, capacitor bushings, etc.	400	1×10^{14}	3

a—Unless otherwise noted, electric strength is for 0.10-inch insulation thickness measured using 1/4 inch ASTM electrodes at room temperature by continuously increasing the test voltage 500 volts/sec.

b—Measured at 1,000 cps; dielectric constant usually varies less than 10 percent from 50 cps to 100 mc.

c—Values are only a guide, since many factors of considerable magnitude are involved: different products of the same type, different manufacturers, widely different requirements of each application, different processing methods. Although these data are the best available, they may differ by a factor of 10 or more from experience with a particular silicone in a single application. Data tabulated for 200 C and 400 C are generally extrapolated from test results at 225 C to 300 C.

d—Measured on 0.003-inch-thick film on aluminum panel.

Silicone Dielectrics

SILICONES comprise a premium grade of insulation noted for their combination of engineering properties. As shown in Table I, silicone insulation is available in a wide range of forms.

The dielectric properties of silicones remain relatively constant over a wide temperature range. In most cases, high electric strength and low dielectric constant are little affected by temperature. Dielectric losses are usually lower at temperatures of 200 C and above.

Other characteristics, advantageous in many electronic applications, include physiological inertness, resistance to weathering, water repellency, relatively high thermal conductivity and arc resistance.

At 25 C

Dissipation Factor		Mechanical Properties of Different Types	Reliability Average Life[e] in Hours at Temperature C			
at 100 cps	at 1 mc		200 C	250 C	300 C	400 C
0.010	0.003	200–400 percent elongation, 100–400 psi tensile strength	3,000	300	5	.....[i]
0.003	0.001	100–600 percent elongation, 300–1,500 psi tensile strength	20,000	5,000	500	<0.1
0.006	0.002	8,000 psi flex strength, 4,000 psi tensile strength	730,000	>10,000	> 2,000	> 10
0.00005	<0.0001	20–1,000 cstk viscosity	715,000[g]	7,500[g]	>100[g]	.....[i]
0.0002	0.0005	Evaporation 24 hr/200 C—2.0–5.0 percent	20,000	<20	<2	.....[i]
0.004	0.003	Low bond strength at 200 C	60,000	4,000	350	10
0.002	0.001	7,500 psi flex strength, 3,500 psi tensile strength	>20,000	>5,000	>1,000	>5
0.003	0.003	High bond strength at 150 C	6,000	300	30	<1.0
0.002	0.001	High water repellency	60,000	4,000	300	10
0.00005	<0.0001	21 dynes/cm surface tension	100,000	5,000	400	10
0.005	0.002-	Available on tapes with glass cloth, silicone rubber, Teflon, or aluminum backing	20,000	4,000	100	0
0.001	0.001	5–25 lb/in peel strength, silicone rubber to aluminum	20,000	5,000	500	<0.1
0.010	0.003	200–400 percent elongation, 100–400 psi tensile strength	3,000	300	5	.....[i]
0.0002	0.0005	Penetration, worked, 250–350	20,000	<20	<10	.....[i]
0.004[f]	.....[i]	Capacitors hermetically sealed	Dependent upon other materials used in making the capacitors.			
0.008[f]	.....[i]	Capacitors need not be sealed				
0.004	0.018	Passes 1 X mandrel test	10,000	400	15	.....
0.004	0.003	Repeated scrape abrasion; 70–120 strokes	>100,000	50,000	800	50[j]
0.004	0.001	200–450 percent elongation, 600–1500 psi tensile strength	10,000	2,500	250	<0.1
0.006	0.004	12,000 psi flex strength; 4500 psi tensile strength	>200,000	>50,000	>10,000	>200
0.003	0.001	100–600 percent elongation; 300–1500 psi tensile strength	20,000	5,000	500	<0.1
0.004	0.001	10,000–50,000 psi flex strength; 15,000–30,000 psi tensile strength	20,000	5,000	300	15
0.005[h]	0.002	Flexible thin high-voltage insulation	>100,000	10,000	1,000	25
0.004	0.001	200–450 percent elongation, 600–1500 psi tensile strength	20,000	5,000	500	<0.1

e—Measured on 0.010-in. thickness using 0.50 in. spherical electrodes.
f—Measured at 1,000 cps in combination with capacitor tissue.
g—In absence of oxygen.
h—Measured on 0.001-in. thickness using 0.50 in. spherical electrodes.
i—Not applicable.
j—Not suggested for use at 400 C for oven short durations.

Tunable F-M Multiplex

Novel heterodyne system eliminates complex filter design for multiplex f-m reception. Different subcarrier frequencies may be accommodated by varying oscillator frequency. Up to 50-kc bandwidth is obtained using 455-kc center frequency. Muting circuit removes audio output when no subcarrier is present

By **W. B. BERNARD,** Capt., U.S.N., Bureau of Ships, Washington, D. C.

MULTIPLEX f-m systems are coming into more and more use for the transmission of one or more channels of intelligence in addition to the primary channel that carries the standard f-m broadcast. At the present time most of these multiplexed channels are used for commercial music service. Some stations are using multiplex on an experimental basis for the transmission of the second channel of a stereophonic broadcast.

The first channel of such programs are carried on the primary f-m carrier.

When there is only one subcarrier associated with the primary signal, the minimum means of separating it from the primary signal is by a high-pass filter. Since an elementary form of filter is not likely to give sufficient discrimination against the stronger primary signal, a multisection filter is usually used.

When the use of a more complex filter is considered, phase shift properties become important. Usually it is easy to calculate the phase response of a filter in the stop band, but the calculation of the phase response in the passband becomes involved. The optimizing of phase-shift characteristics also presents problems. A simple high-pass filter suffers from the difficulty that an unnecessarily wide band of noise is presented to the detector which can result in an inferior signal-to-noise ratio at the detector output.

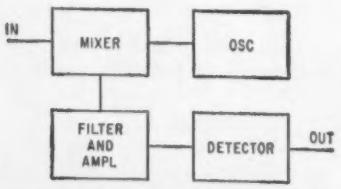


FIG. 1—Block diagram of heterodyne multiplex adapter. Unit is basically 455-kc superheterodyne whose input is subcarrier frequency and output is multiplexed audio

When the best signal-to-noise ratio is desired at the output of the multiplex system, or if more than one subcarrier is being transmitted, it becomes necessary to use band-pass filters to select the desired information and reject the noise and undesired signals. As no multiplex standards have as yet been set, it may become necessary at some later date to set the filters to other than the original frequencies. The adjustment of a multisection filter to a new frequency is a complicated process usually calling for the redesign and replacement of filter components.

Filter Problems

A modern wide-range, high-fidelity audio system may have considerable response at the subcarrier frequency. As there is not a great difference between the audio frequencies to be recovered and the frequency of the subcarrier itself, problems arise in the satisfactory filtering of the detector output.

These difficulties may be greatly reduced or eliminated by heterodyning the subcarrier up to a new higher frequency. At the higher frequency, the selectivity necessary for the selection of the desired signal may be obtained by conventional tuned circuits and detection may be accomplished with conventional f-m detection circuits. The block diagram of a heterodyne adapter is shown in Fig. 1. The subcarrier signal is coupled from the multiplex output of an f-m tuner (before de-emphasis) to the adapter mixer where it beats with a local oscillator to produce a 455-kc i-f output signal.

Tuning heterodyne adapter to desired subcarrier of f-m transmission. Heterodyne adapter couples to multiplex outlet of any f-m tuner

This desired output signal is selected by tuned circuits, amplified, limited and detected.

R-F Circuits

The circuit of the experimental adapter is shown in Fig. 2. The multiplex subcarrier from the f-m receiver is coupled to the adapter

Adapter for Stereo

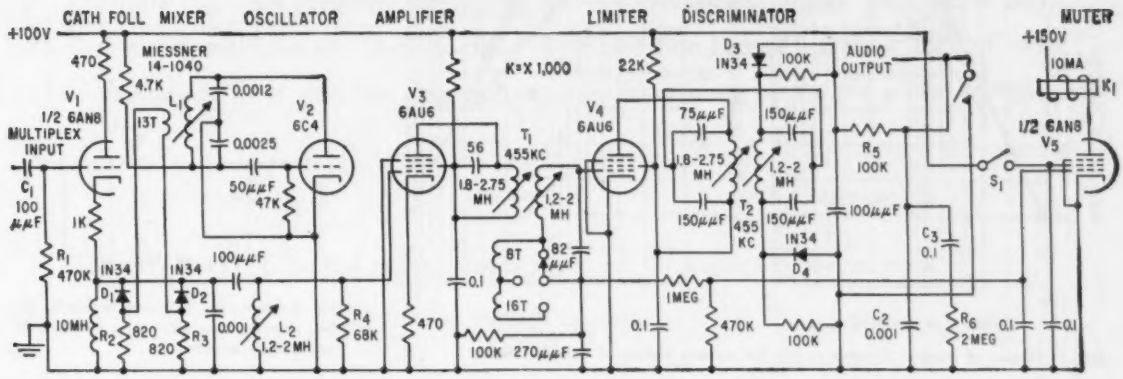


FIG. 2—Cathode follower matches input to balanced mixer. Conventional f-m circuits amplify, limit and demodulate i-f signals. Muting circuit grounds audio output with no subcarrier present

through cathode follower V_1 through the simple high-pass network of C_1 and R_1. This high-pass filter passes the subcarrier frequencies and attenuates the audio frequencies present.

A cathode follower is used for isolation between the input circuit and the balanced mixer D_1 and D_2 and to reduce the input impedance to that suitable for use by the balanced mixer.

Oscillator

The local oscillator V_2 is connected as a Colpitts-type oscillator. The secondary winding of oscillator coil L_1 develops approximately 2 volts across the two detector resistors R_2 and R_3. These resistors balance the voltages to ground.

The output of the mixer is coupled to single-tuned circuit L_2 which selects the 455-kc component of the mixer output. This signal is coupled to amplifier V_3. Tuned circuit L_2 is loaded by R_4 to obtain the proper Q and selectivity.

Amplifier

The amplifier output is supplied to limiter V_4 through variable selectivity double-tuned transformer T_1. Transformer T_1 was made by winding 24 turns of No. 26 dcc wire, tapped at 8 turns, adjacent to the transformer primary winding. Three steps of selectivity are available: 5 kc, 10 kc and 20 kc. The Q of the double-tuned circuit is such that the single-tuned circuit response fills in the valley of the double-tuned circuit response when it becomes overcoupled.

Limiter V_4 drives discriminator transformer T_2 and the signal is detected by discriminator D_3 and D_4. The resulting audio signal is passed through the deemphasis network consisting of R_5 and C_2 and through the contacts of muting relay K_1 to the external audio system.

The muting circuit is so arranged that when there is no subcarrier signal present, the audio output of the adapter is shorted to ground.

Muting Circuit

Muting is accomplished by single-contact, normally-open relay K_1 whose coil is in the plate circuit of muting tube V_5. Part of the rectified d-c voltage developed at the control grid of limiter V_4 is applied to the control grid of muter tube V_5. When a subcarrier is present, the voltage at this grid will be negative cutting off muter V_5, thus reducing the plate current and maintaining relay K_1 in the open condition. When the relay is open, audio signals are allowed to pass to the external audio system.

When the subcarrier is not present at the limiter grid, the voltage at the control grid of muter V_5 approaches ground potential causing its plate current to rise high enough to energize relay K_1 shorting the audio signal to ground. Blocking capacitor C_3 and bleeder resistor or R_6 eliminate pops and clicks which might result from opening and closing of muting relay when there is a d-c output from the discriminator. Switch S_1 is in series with the screen voltage supply of the muter tube and may be used to disable the muting feature.

Performance

The heterodyne multiplex adapter can be tuned to accept many subcarrier frequencies by varying the oscillator frequency. As the subcarrier frequency becomes lower, it becomes necessary to use the narrower bandwidth settings. Full 20-kc bandwidth is available at the commonly used 43-kc subcarrier frequency. Experimentation has shown that bandwidths up to 50 kc may be obtained using the 455-kc center frequency.

Bandwidths down to approximately 2 kc may be obtained by employing 175 kc or 262 kc as center frequency.

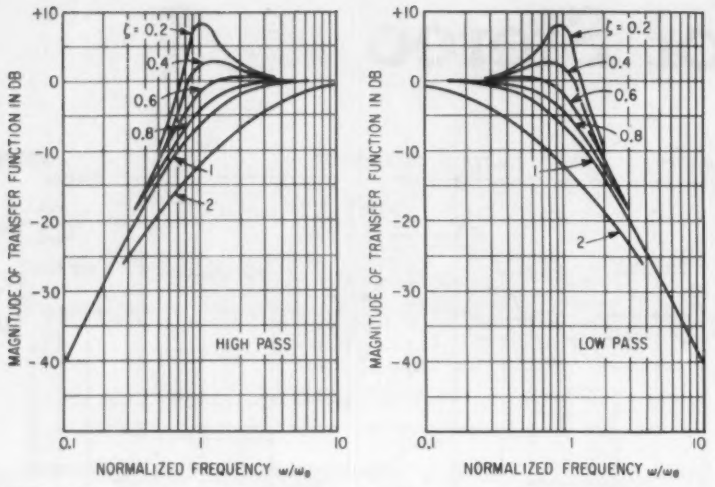


FIG. 1—Shapes of transfer function curves for various values of damping factor

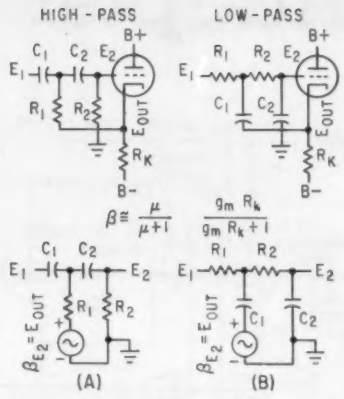


FIG. 2—High-pass (A) and low-pass (B) filter unit showing equivalent circuit with zero output impedance

How to Design

PASSIVE R-C filters are extremely useful in high-, low- and band-pass applications. Stringent requirements, however, often demand either more general passive circuits containing inductance or active networks containing tubes or transistors. At low frequencies, suitable high-quality inductors tend to be expensive, heavy and susceptible to hum pickup. For this reason, active R-C filters are extensively used. The circuit to be described has performance characteristics comparable to the two- or three-tube feedback circuits commonly used but is much simpler and cheaper to build.

These filters are applicable for frequencies from d-c to values so high that stray capacitance becomes a limiting factor. The useful range is through the audio spectrum to approximately 100 kc. With care, operation to a few mc may be possible.

The basic filter unit[1] consists of a cathode follower plus two resistors and two capacitors which may be wired either as a high-pass or low-pass filter having in either case 12-db/octave attenuation slope. These units may be cascaded to give high-, low- or band-pass filtering with attenuation slopes that are any desired multiple of 12-db/octave.

In the filter theory discussion, the variable s is the complex frequency variable. To obtain the complex number representation for the response to sinusoidal inputs set $s = j\omega$, where $j = \sqrt{-1}$ and ω is the frequency in rad/sec. To match published graphical data[2], results are put into standard forms for quadratic transfer functions $E_2/E_1 = N/(s^2 + 2\,\zeta\,\omega_o s + \omega_o^2)$ where $N = s^2$ for high-pass filters or ω_o^2 for low-pass filters, ζ (zeta) is a dimensionless parameter called damping factor and is a measure of the sharpness of transition from the passband to the rejection band and ω_o is the corner frequency with dimensions in rad/sec. The corner frequency locates the nominal transition point between pass and rejection bands. Figure 1 shows the magnitude plotted against frequency for several values of damping factor. If the damping factor is greater than 1, the system will be overdamped (as with all passive R-C filters). The transient response will be sluggish and the frequency response has a broad, gradual transition region. When the damping factor is 1, the system is critically damped. The transient response is the fastest possible without overshoot or ringing and the frequency response has a moderately sharp transition. When the damping factor is less than 1, the system is underdamped. In this case, the transient response is rapid but has overshoot. With low values of damping factor, pronounced ringing will occur. The frequency response tends to have sharp transition possibly with a hump near the corner frequency. The exact choice of damping factor depends upon the application and upon what may be in cascade with the filter, but values in the range 0.5 to 1 are most commonly used.

Basic Filters

The basic form of the high-pass filter is shown in Fig. 2A, top. When a negative (B) supply is not available, other methods of establishing d-c level for the vacuum tube may be used. If it is assumed that the cathode follower has a zero output impedance, the equivalent circuit is as shown in Fig. 2A, bottom, and the transfer function, corner frequency and damping factor may be calculated from Table 1.

The basic form of the low-pass filter is shown in Fig. 2B, top, with the equivalent circuit below. As

Single triode plus three resistors and two capacitors comprise network that may be either high- or low-pass filter having 12-db/octave attenuation. Filters can be cascaded for high-, low- or band-pass filters with slope any desired multiple of 12-db/octave with insertion loss of less than 2 db. Once designed, filter can be changed to new frequency by simple scale changes

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Low Cost Audio Filters

for the high-pass filter, all calculations may be made from Table 1.

Designing a Symmetrical Circuit

For damping factors greater than 0.5, the symmetrical design procedure may be used. This method has three advantages: design formulas for C_1, C_2, R_1 and R_2 are the same for both high- and low-pass filters; a high-pass filter may be converted into a low-pass filter (and reverse) with the same corner frequency and damping factor merely by interchanging R_1 with C_1 and R_2 with C_2; and the circuit becomes insensitive to tube parameter variations.

Symmetry of design occurs when $R_1 C_1 = R_2 C_2 = 1/\omega_o$. See Table 1 for definitions.

The transfer function becomes:

$$\frac{E_2}{E_1} = \frac{s^2 \text{ (high-pass) or } \omega_o^2 \text{ (low-pass)}}{s^2 + (\alpha + \gamma)\omega_o s + \omega_o^2}$$

Choose a damping factor greater than 0.5 (damping factor $= (\alpha + \gamma)/2$), a corner frequency in rad/sec and determine the value of $\alpha = 1 - \beta$.

Determine γ from $\gamma = 2\zeta - \alpha$. This value must exceed unity. If it does not, a smaller α or a larger ζ must be chosen.

Choose C_1 arbitrarily. Calculate $C_2 = (\gamma - 1)C_1$; $R_1 = 1/(\omega_o C_1)$; and $R_2 = 1/(\omega_o C_2)$.

As an example; suppose $\zeta = 0.6$, $\omega_o = 100$ and $\alpha = 0.1$. Then $\gamma = 1.1$, $C_1 = 0.01$ μf (chosen arbitrarily), $C_2 = 0.001$ μf, $R_1 = 1$ meg and $R_2 = 10$ meg.

If necessary, or desirable, a change in impedance level may now be made by multiplying the resistance values and dividing the capacitance values by the same factor. For practical reasons, the impedance level should be kept high.

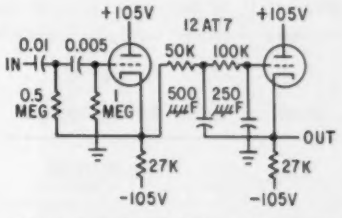

FIG. 3—Example of high- and low-pass filters cascaded to give band-pass action. Corner frequencies are 200 radians per sec (32 cps), and 40,000 radians per second (6,370 cps) respectively. Damping factor for each filter is 0.75

Other Design Procedure

Symmetrical design cannot be used for damping factors of 0.5 or less. For fixed α and γ, the smallest possible value of damping factor is $\zeta_{min} = \sqrt{\alpha\gamma}$. Design equations for obtaining this value are given in reference[3]. An infinite number of trial and error solutions also exist for any $\zeta > \zeta_{min}$.

Deviations from Idealized Theory

The output impedance of a cathode follower is not zero but typically several hundred to one thousand ohms. In a high-pass filter this deviation from the assumptions in the simple theory has never been found troublesome. In a low-pass filter however, a measurable effect often occurs at frequencies so high that the reactance of C_1 becomes comparable to the cathode follower output impedance. Typically, this effect shows in the gain against frequency curve as a rejection notch (at some frequency above corner frequency) after which the attenuation curve approaches −6 db/octave instead of −12 db/octave.

If this effect is large enough to be troublesome, one or more of three methods of reducing its magnitude may be used: a cathode follower may be used with a lower output impedance; the impedance level of the R-C network may be raised; or a bypass capacitor may be placed

across the cathode resistor.

An illustrative circuit of a high-pass and low-pass filter cascaded to give band-pass characteristics is shown in Fig. 3. Using handbook values of $\mu = 60$ and $g_m = 4{,}000$ μmhos for the 12AT7, α was computed from

$$\beta \cong \frac{\mu}{\mu + 1} \frac{g_m R_K}{g_m R_K + 1} = 0.975$$

therefore

$$\alpha = 1 - \beta = 0.025$$

Figure 4 shows theoretical frequency response. Note the notch and leveling of the curve at high frequencies. This effect is a typical deviation from the theoretically anticipated curve for a low-pass filter.

Composite Filters

As a result of the low output impedance of these filter circuits, cascading of individual units is possible without the need for intermediate buffer stages. A small insertion loss (usually 0.5 to 1 db) means that multiple cascading does not cause the signal level to deteriorate significantly. As a result, composite filters with high-, low-, or band-pass characteristics with attenuation slopes of any desired multiple of 12-db per octave are easily obtained.

It is possible to cascade these filters with passive R-C filters. In this case, use of a fairly low damping factor for the active filter will tend to compensate for the inherent droop of the passive filter response. In practice, the addition of passive units often necessitates the use of an additional buffer stage. In this case, another active filter may be as cheap as the passive one.

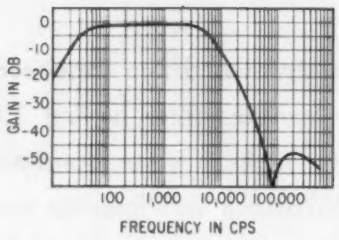

FIG. 4—Theoretical frequency response agreed with actual response

Variation of Corner Frequency

Any satisfactory filter circuit (Fig. 3 for example) can be changed to a new corner frequency by a simple scale change of C's or R's. The change in corner frequency does not affect the damping factor.

Continuous tuning of the corner frequency can be achieved by using ganged capacitors for C_1 and C_2 or ganged resistors for R_1 and R_2. When capacitance or resistance variation is linear with shaft rotation, the corner frequency will vary inversely with shaft rotation.

The insertion loss of one active filter unit is the gain loss of the cathode follower and is typically less than 1 or 2 db. Near the corner frequency it is possible to get greater voltage out than put in when values of damping factor corresponding to humps in the response curves near the corner frequency are used.

The output impedance in an exact sense undoubtedly is a function of frequency. For all practical purposes it is approximately several hundred to 1,000-ohms resistive.

The circuit is inherently stable. There is no possibility that an increase or decrease of the transconductance or amplification factor of the tube can cause instability.

Sensitivity

The sensitivity of the response characteristics to parameter changes is quite low. To an extremely good approximation, the corner frequency depends only on the passive components and not at all upon tube parameters. The damping factor depends upon the gain of the tube, but the gain of a cathode follower is quite insensitive to changes in tube parameters at least when the amplification factor is large.

Linearity is essentially as good as for an ordinary cathode follower circut. Large signals may be handled by properly adjusting the d-c levels of voltage and current.

Applications

Many applications for these filter units exist. In audio, they may be used for rumble or hiss suppression, crossover networks and f-m multiplex circuit use; in industrial electronics, filtering transducer outputs, radio propagation signals, servo control signals and quantization of noise. In laboratory use, they can function as a universal high-, low-, and band-pass filter. With symmetrical design, any individual unit could be used either as high- or low-pass, the choice being made by simple switching. With continuously variable resistance or capacitance, variable tuning is possible.

Table I—Formulas and Parameters Used in Basic Filter Design

	Transfer Function	Corner Frequency	Damping Factor
High-Pass	$\frac{E_2}{E_1} = \frac{s^2}{s^2 + (\alpha\omega_1 + \gamma\omega_2)s + \omega_1\omega_2}$	$\omega_o = \sqrt{\omega_1\omega_2}$	$\zeta = \frac{\alpha\omega_1 + \gamma\omega_2}{2\omega_o}$
Low-Pass	$\frac{E_2}{E_1} = \frac{\omega_1\omega_2}{s^2 + (\gamma'\omega_1 + \alpha\omega_2)s + \omega_1\omega_2}$	$\omega_o = \sqrt{\omega_1\omega_2}$	$\zeta = \frac{\gamma'\omega_1 + \alpha\omega_2}{2\omega_o}$

Definitions

$\alpha = 1 - \beta$

$\gamma = \frac{C_1 + C_2}{C_1} = 1 + \frac{C_2}{C_1}$

$\omega_1 = \frac{1}{R_1C_1}$

$\omega_2 = \frac{1}{R_2C_2}$

ω_o = corner freq. in rad/sec

ζ = damping factor

β = cathode follower gain

$\gamma' = \frac{R_1 + R_2}{R_2} = 1 + \frac{R_1}{R_2}$

s = complex frequency variable ($=j\omega$ for sinusoidal responses)

REFERENCES

(1) Patent Pending.
(2) H. Chestnut and R. Mayer, "Servomechanisms and Regulating System Design," I, John Wiley & Son, 1951.
(3) W. D. Fryer, High-, Low-, and Band-Pass Filters for Audio and Sub-Audio Frequencies, Cornell Aeronautical Lab.

Silicon Power Rectifiers

Current carrying capacities of 200 ma to 140 amp at 150 C and peak inverse voltages of 50 to 600 v are obtained in military units

By **ROBERT F. EDWARDS,** President's Assistant for Planning, International Rectifier Corp., El Segundo, Calif.

DEVELOPED BY the military services to provide sufficient rectifier production in the event of industrial mobilization, silicon power rectifiers have reached mass production and standardization.

Table I lists the entire series of EIA and military standard silicon power diode mechanical configurations. There is still some variation in current ratings between the services for identical mechanical configurations. Lower ratings are in parenthesis.

The standard sizes are based on incremental changes in rectifying area of the silicon *p-n* junction, as well as current carrying capacity. Stud mounted units are rated at 135-150 C case temperature and pigtail mounted units are rated at 150 C ambient temperature. The 250-ma diodes are pigtail types and all others listed are stud mounted.

A rectifier can be selected from this list for nearly every application. Typical current—temperature curves, for the 35-, 70- and 140-amp diodes, are given in Fig. 1. These show the absolute maximum rectified diode current as a function of diode base current. Such curves are not part of the standard and may vary from manufacturer to manufacturer.

Use of standard parts by equipment designers eliminates delays. In addition, it assures parts approval by military buyers.

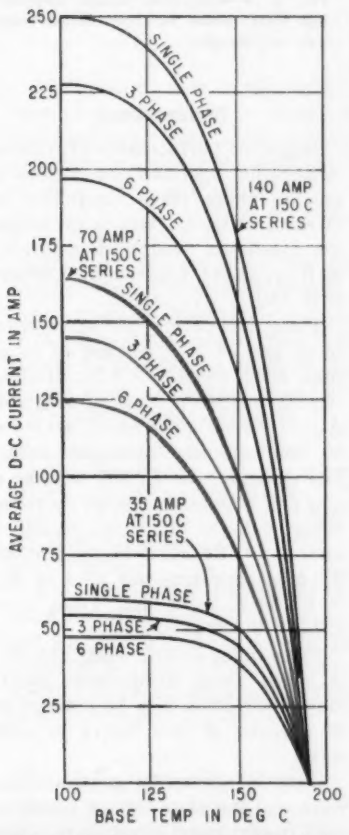

FIG. 1—Absolute maximum rectified diode current as a function temperature

Table I—Current Rating and Peak Inverse Voltage of EIA and Military Standard Silicon Power Diodes

Part Number	Specification Number	Approved as Standard by:	Current at 150 C	PIV (volts)
JAN 1N538	MIL-E-1/1084A	ASESA	250 ma	200
JAN 1N540	MIL-E-1/1085A	ASESA	250 ma	400
JAN 1N547	MIL-E-1/1083A	ASESA	250 ma	600
JAN 1N253	MIL-E-1/1024A	ASESA	1 amp	100
JAN 1N254	MIL-E-1/989B	ASESA	400 ma	200
JAN 1N255	MIL-E-1/990B	ASESA	400 ma	400
JAN 1N256	MIL-E-1/991B	ASESA	200 ma	600
USAF 1N1200	MIL-E-1/1108 (USAF)	USAF, USN (6A) USA (5A)	12A	100
USAF 1N1202	MIL-E-1/1108 (USAF)	USAF, USN (6A) USA (5A)	12 A	200
USAF 1N1204	MIL-E-1/1108 (USAF)	USAF, USN (6A) USA (5A)	12 A	400
USAF 1N1206	MIL-E-1/1108 (USAF)	USAF, USN (6A)	12 A	600
*USAF 1N1184	MIL-E-1/1135 (USAF)	USAF, USN (USA 20A)	35 A	100
*USAF 1N1186	MIL-E-1/1135 (USAF)	USAF, USN (USA 20A)	35 A	200
*USAF 1N1188	MIL-E-1/1135 (USAF)	USAF, USN (USA 20A)	35 A	400
USAF 1N1190	MIL-E-1/1135 (USAF)	USAF, USN	35 A	600
USAF 1N1282	MIL-E-1/1136 (USAF)	USAF, USN, USA (50A)	70 A	100
USAF 1N1284	MIL-E-1/1136 (USAF)	USAF, USN, USA (50A)	70 A	200
USAF 1N1286	MIL-E-1/1136 (USAF)	USAF, USN	70 A	400
USAF 1N1288	MIL-E-1/1136 (USAF)	USAF, USN	70 A	600
1N2054–	66–2435	USN	140	50
1N2056–	66–2435	USN	140	150
1N2059–	66–2435	USN	140	300
1N2064–	66–2435	USN	140	600

*Qualification will be attempted for the USA specifications (1N249B, 1N250B, 1N2135A)

Audio Amplifier Design

Plate dissipation in class-A and class-B audio amplifiers is substantially reduced by feeding a superaudible signal to the grid in addition to the desired signal. Maximum dissipation of class-A amplifier may be cut to 41 percent of that of a conventional class-A amplifier, and maximum dissipation may be halved in a class-B amplifier

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PLATE DISSIPATION of class-A or class-B audio amplifiers can be reduced as much as 41 and 50 percent, respectively. The reduction is obtained by feeding an auxiliary signal to the amplifier grid.

The auxiliary signal at superaudible frequency is adjusted in amplitude so that its positive peaks never cause peak plate current to exceed maximum current peak of the desired signal. Similarly, amplitude is adjusted so as never to cause clipping of the auxiliary signal on the negative peaks.

Class-A Amplifier

In a class-A amplifier of conventional design, with no input signal all plate input power is dissipated on the plate. With an input signal, useful output is obtained in an external circuit and plate dissipation is reduced correspondingly. With the arrangement to be described, some input is provided to the tube on all occasions except when the tube is being driven to peak plate current. So that the additional input does not interfere with the desired low-frequency signal, a superaudible frequency was chosen.

Two cycles of audio frequency are shown in Fig. 1 for a conventional class-A amplifier following a no-signal region. Average d-c plate current is constant whether the audio is present or not. The same two cycles are shown in Fig. 2 with an auxiliary signal added to give the amplifier something to do at all times except when it is called upon to deliver maximum plate current. The auxiliary signal rides evenly in a positive and negative direction about the low-frequency signal as an axis so as not to disturb average low-frequency current.

The plate circuit of the class-A amplifier has two load circuits, one for the auxiliary frequency and one for the low-frequency audio, as shown in Fig. 3. Load for the superaudible frequency is shown as resistor R bypassed for low frequencies by inductance L.

The wave shape of the auxiliary signal may be sinusoidal or it may be a square wave. The plate circuit for the auxiliary signal may be tuned for the sinusoidal wave or the fundamental component of the square wave. It may also have broad response, resembling a video amplifier and producing essentially square waves of the auxiliary signal from the square-wave grid excitation. Reduction of plate dissipation depends on the choice of these factors and in general improves with square waves.

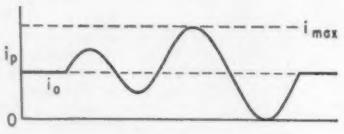


FIG. 1—Plate current in conventional class-A amplifier

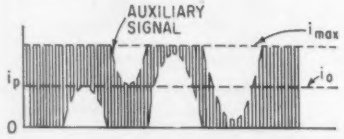


FIG. 2—Class-A amplifier plate current with auxiliary signal added

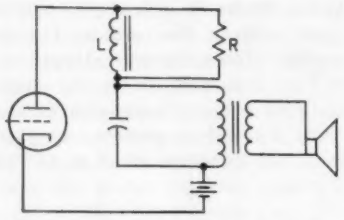


FIG. 3—Low-dissipation class-A amplifier has plate circuits for both desired and auxiliary signals

Performance

Expected performance of a class-A amplifier operated conventionally and in these three conditions is shown in Fig. 4. Data is presented as maximum watts dissipation/watt input as a function of k, where $k = (E_b - E_{b\,min})/E_b$.

Plate dissipation can be reduced to as low as 40.5 percent of original. Even when $k = 0.91$, dissipation is only 46 percent of original. A k of 0.91 is quite easily achieved in commercially available tubes. For example, the 6V6GT attains a k of 0.91 when operated at its rated value of $E_b = 315$ v, $E_{sc} = 225$ v and $i_o = 34$ ma. Plate voltage $E_{b\,min}$ is approximately 28 v at $E_{sl} = 0$ and $I_b = 68$ ma. Thus, $k = (315 - 28)/315 = 0.91$.

Plate input is 10.7 watts. If this is called rated dissipation, maximum dissipation may be reduced to 46 percent of this figure or 4.93 watts.

With a sinusoidal superaudible wave and the plate circuit tuned to the fundamental frequency, net plate dissipation as a function of

Cuts Plate Dissipation

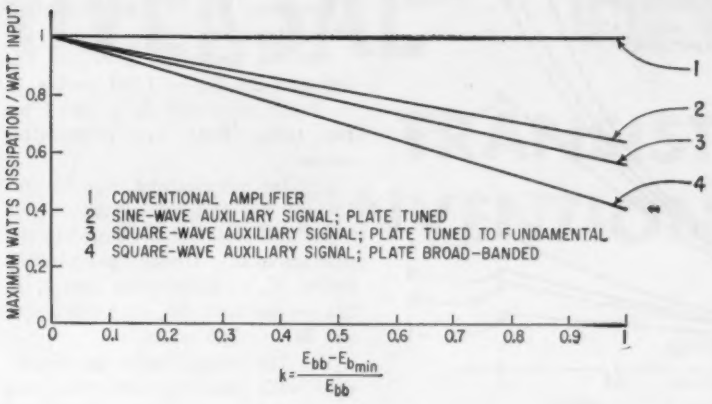


FIG. 4—Maximum dissipation against k for class-A amplifier with 1-watt input

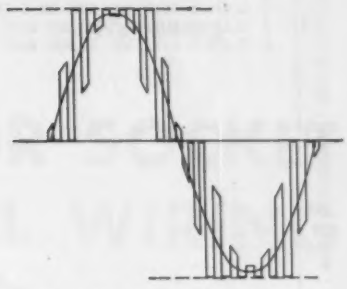


FIG. 5—Class-B amplifier plate voltage with auxiliary signal added

amplitude, m, of the desired low-frequency wave (where m has a minimum value of 1) is

$$W_{diss}=E_{bb}I_b\left[1-k\left(\tfrac{1}{2}+\frac{3m^2}{4}-\frac{2m}{\pi}\right)\right]$$

The value of m that yields maximum dissipation may be found by differentiating this equation with respect to m, setting the differential equal to zero and solving for m. Thus, $m = 4/3\,\pi = 0.425$ for maximum dissipation.

Similarly, the equation for dissipation as a function of m and k for a square superaudible signal but with the plate auxiliary circuit tuned to the fundamental of the square wave to produce essentially a sinusoidal plate voltage is

$$W_{diss}=E_{bb}I_b\left\{1-k\left[\frac{2}{\pi}+\left(\tfrac{1}{2}+\frac{1}{\pi}\right)m^2-\frac{8m}{\pi^2}\right]\right\}$$

By differentiation, $m = 8/(\pi^2 + 2\pi) = 0.495$.

The equation for dissipation as a function of m and k for a superaudible square wave but with the auxiliary plate circuit broad-banded to cause the plate voltage waveform to be essentially square is

$$W_{diss}=E_{bb}I_b\left[1-k\left(1+m^2-\frac{4m}{\pi}\right)\right]$$

and by differentiation, $m = 2/\pi = 0.636$ for maximum dissipation.

The class-B amplifier is typified by its zero-signal plate current being essentially zero and by the positive and negative half cycles of audio frequency plate currents being handled by separate tubes. Figure 5 shows how the plate voltages from one plate to the other appear when the auxiliary signal is added. This signal is different from the class-A case in that no auxiliary signal is present when the low-frequency is zero.

Again, the auxiliary signal may be sinusoidal or square at the grids and may be sinusoidal or square at the plates. Figure 6 shows how maximum dissipation is reduced when the auxiliary signal is added as a function of k. Conditions are those of a conventional class-B amplifier, with a sinewave auxiliary signal and plate tuned to the fundamental, with a square wave auxiliary signal and the plate tuned to the fundamental of the square wave, and with a square wave auxiliary signal and the plate broadly tuned to accept all harmonics of the square wave.

Data of Fig. 6 is presented as maximum dissipation vs k for constant input of one watt under maximum signal conditions. Maximum dissipation may occur at a value less than maximum signal input.

At $k = 1$, maximum dissipation may be cut in half, and for $k = 0.9$ (a value usually attainable),

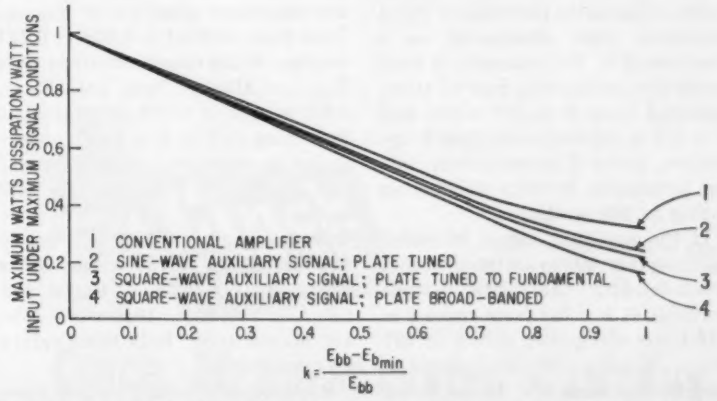


FIG. 6—Maximum dissipation against k for class-B amplifier operated under four conditions. Input is constant at 1 watt under maximum signal conditions

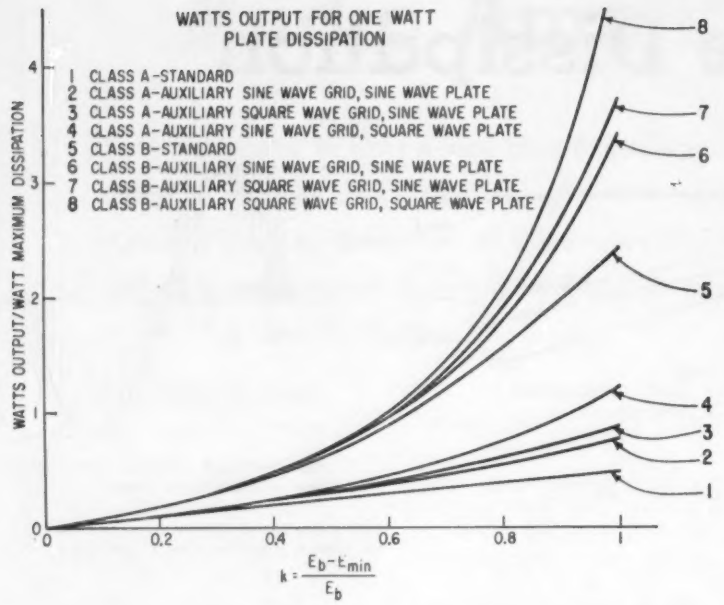


FIG. 7—Power output/watt maximum rated plate dissipation for class-A and class-B amplifiers operating under conventional and various auxiliary signal conditions

maximum dissipation may be cut to 63 percent of conventional.

Increased Output Power

The auxiliary signal immediately reduces plate dissipation without altering input power or useful output power. A possibility also exists of increasing input power and therefore obtaining more useful output power while operating tubes within rated dissipation. This possibility exists whenever d-c plate voltage or d-c plate current or both may be increased within the operating limits of the tube. Figure 7 shows these possibilities.

The curves show maximum power output obtainable per watt of rated maximum plate dissipation as a function of k. For example, if total rated dissipation of a pair of tubes operated class B is 250 watts and $k = 0.9$ in conventional class-B operation, curve 5 shows power output obtainable is twice dissipation rating or 500 watts.

If the auxiliary signal is added using square waves at the grid and broad-banding the plate, output available at $k = 0.9$ from curve 8 is 3.18 times dissipation rating or 797 watts. Whether increased input is permissible must be investigated for the particular tube.

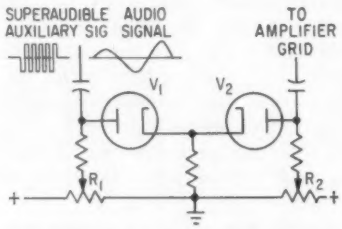


FIG. 8—Grid excitation circuit for class-A amplifier with auxiliary signal

Assume a pair of type 810 triodes operated class B. Each tube is rated at 125 watts plate dissipation under CCS operating conditions, with maximum d-c plate voltage 2,500 v and maximum plate d-c of 250 ma. Peak plate current is $0.25\pi = 0.785$ ampere, which may be attained with $E_{b\,min}$ of 160 v. Thus, with E_b = 2,500 v, a k of 0.936 is attainable. Referring to Fig. 7, curve 5, output under conventional class-B operation is $W_o = 2.15(250) = 537$ watts.

Power input is $W_{in} = 4W_o/k\pi = 4(537)/0.936\pi = 730$ watts. Since $E_b/I_b = 2{,}500/0.25 = 10{,}000$ and $2E_b I_b = 730$, $E_b = 1910$ v and I_b = 191 ma per tube. Both these values are permissible.

Suppose an auxiliary square wave is added and the plate circuit is broad-banded. Curve 8, Fig. 7, shows that useful output may be 3.7 times rated dissipation of 925 watts.

Input has been increased by the ratio of curve 1 to curve 4 of Fig. 6, or by the ratio of 0.34 to 0.2. Therefore, $W_{in} = 730\ (0.34/0.2) = 1{,}241$ watts.

Solving equations $E_b/I_b = 10{,}000$ and $2E_b/I_b = 1{,}241$ yields $E_b = 2{,}491$ volts and $I_b = 249.1$ ma per tube. Both are permissible values.

Similar calculations may be performed for the square wave grid input and plate circuit tuned to the fundamental. Under permissible limits, $E_b = 2{,}260$ volts and $I_b = 226$ ma per tube. $W_{in} = 1{,}020$ watts and $W_o = 750$ watts.

The 750 watts should be obtainable with practical circuits; the 925-watt figure is theoretically obtainable if the superaudible plate circuit is truly broad-banded. However, if some higher harmonics are attenuated, less than 925 watts would be obtained, approaching the 750-watt figure when only the fundamental is left.

Amplifier Input Circuit

One of many possible circuits for producing the grid excitation is shown in Fig. 8. It is suitable for the class-A amplifier. Each plate is provided with a resistive impedance to ground, and is arranged to be biased into conduction by potentiometers connected to B plus.

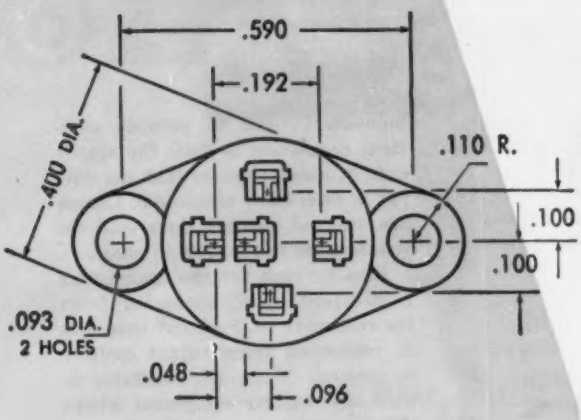
Input signals consisting of a superaudible wave and the desired audio signal are fed through a blocking capacitor to one plate. Output is taken from the other plate through a suitable blocking capacitor. The circuit is adjusted so that with a constant amplitude superaudible frequency, potentiometer R_1 is set to just clip the negative-going half cycle of the auxiliary wave. Potentiometer R_2 is set to just clip the positive-going half cycle of the auxiliary wave.

When audio is applied, output will be as shown in Fig. 2. Maximum audio input will be that level which at its peaks just reduces the auxiliary signal to zero. The auxiliary signal should cause plate current to go through the excursion of zero plate current to the plate current at zero grid-bias voltage.

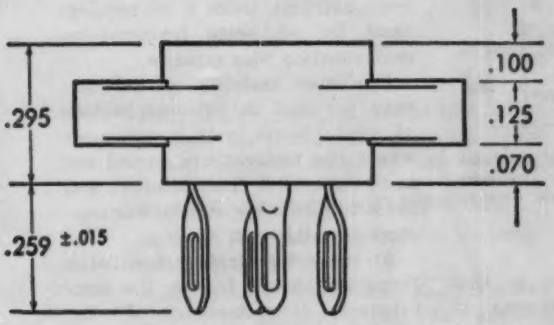
UNIVERSAL

No. 24872

TRANSISTOR SOCKET FOR CONVENTIONAL WIRING



No. 24872

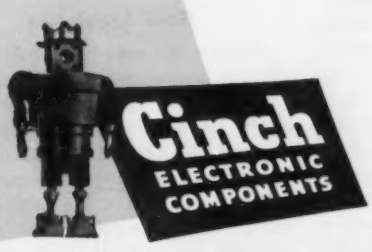


For use with transistors designed to the triangular base layout .2 "x .1" (JETEC-30) contact centers, as well as the three contact in-line (.048 x .192 contact centers). This socket was originally designed for the all transistor TV set; however, its future applications are many; industrial communications, test equipment, bread board circuits, etc.

This design features an exceptional subminiature contact designed for the absolute minimum in intermittent failures, and an all molded monoblock construction with mounting holes provided as part of the casting. Assemblies are available in G. P. Black and low loss Mica-filled Phenolic.

The drawing shows five contacts but any number can be omitted to meet your particular contact layout.

Contacts are of Phosphor bronze, Cadmium plated .0001 (P24).



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CIRCLE 42 READERS SERVICE CARD

Clock Source for Electronic Counters

Small, stable, fixed frequency, 100-kc oscillator is a transistorized version of the Pierce oscillator. When the crystal is replaced with a high-Q inductor-capacitor tuner, it becomes a transistorized Clapp oscillator

By **THOMAS F. MARKER,** Manager, Automated Data Development Dept., Sandia Corp., Albuquerque, New Mexico

APPLICATIONS of transistors to computer and communication equipment today requires small transistorized oscillators with frequency stabilities better than ± 1 part in 10^6. Limitations of space and available power often prevent the use of elaborate circuits to control frequency and output voltage from source oscillators.

The circuit shown in Fig. 1 has been used for applications where a small, stable, fixed-frequency oscillator is needed. The circuit consumes 1.5 percent of the power and can be packaged into less than 10 percent of the space required for an electron-tube equivalent.

The circuit is a transistorized version of the Pierce crystal oscillator. When an E cut crystal plate is employed, the circuit constants are suitable for operation at 100 kc. For stable operation at 60 kc, C_1 and C_2 are increased to 0.01 μf. The tuned circuit consists of the mesh which includes the crystal and C_1, C_2. The capacitors produce an impedance transformation which aids in isolating transistor parameter variations from the crystal. The crystal oscillates in the positive reactance mode slightly above its natural series resonance frequency. To achieve maximum frequency stability, the oscillation frequency should approach the series resonant frequency of the crystal. As the two capacitors across the crystal are made larger, improvement in stability is achieved; however, this is at the expense of requiring more current gain from the transistors. When larger current gains are employed by using more favorable transistor types, the effects of transistor characteristic variations become more pronounced so that only moderate improvements in stability are achieved.

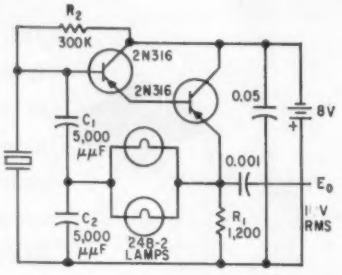

FIG. 1—Stabilized transistor oscillator circuit is used in computer equipment where the temperature is held close to room ambient

Gain Regulation

The circuit uses two 2N316 transistors connected in a composite common emitter configuration. Because of production variations in the current gain of transistors and crystal Q, the gain is automatically adjusted to the value which just sustains oscillation. The lamps, connected between C_1 and C_2 to the output emitter, are used for this function. Two type 24B-2 switchboard lamps connected in parallel between C_1 and C_2 provide sufficient regulation to limit the amplitude of oscillations so that the output is essentially sinusoidal. Lamps are selected so that their cold resistances do not exceed 40 ohms.

Bias current for the transistors is provided by R_2 connected from the collectors to the input base and R_1 connected from output emitter to ground. Since the oscillator is used in computer equipment where the temperature is held close to room ambient, there is no requirement for elaborate temperature-compensating bias circuits.

Oscillator stability varied less than ± 1 part in 10^6 over periods of several hours in an environment where the temperature varied not more than ± 2 F from ambient, and the 8-volt collector supply was constant to ± 0.5 volt.

At room temperature, oscillator frequency closely follows the temperature characteristic of the crystal. With the E plate used, this amounts to a frequency shift of approximately 1 ppm/deg C about the crystal turnover temperature and becomes as large as 4 ppm/deg C at temperatures substantially above and below the turnover temperature. For applications with limited ambient variations, the crystal is enclosed in a small container lined with $\frac{3}{8}$ in. thick Dylite expanded polystyrene foam.

The circuit has been employed in electronic counters as a clock source.

Announcing CMC's
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Standard features designed to improve reliability and flexibility include elimination of stepping switches, 4 line per second printout, parallel entry, and rugged unitized construction.

Key Specifications

Print-out capacity 6 digits standard, up to 12 on special order • Accuracy determined by basic counting instrument • Display time 0.2 seconds minimum, maximum controlled by the counter • Weight 64 lbs. • Price $950. Add $10 for rack mount.

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CIRCLE 49 READERS SERVICE CARD

A-M Sidebands Transmit Stereo

CONVENTIONAL a-m transmitters can easily be converted for stereophonic broadcasting with adapters developed by Kahn Research Labs, Freeport, N. Y. News of the development was received after the article "Recent Developments in Stereo Broadcasting" had been prepared for the April 3, 1959, issue of ELECTRONICS.

Only one transmitter is required, and conventional a-m receivers are used. Monaural reception of stereo programs is also completely compatible on any standard receiver. When stereo broadcasts are not being programmed, the system may be switched to the compatible single-sideband mode.

The combined stereo/compatible single-sideband system is illustrated in the simplified block diagram of Fig. 1. During stereo operation, two sidebands are produced that are independently modulated by the two stereo channels. The resulting envelope wave has the same spectrum requirements as conventional a-m and is theoretically free from inherent distortion. In actual practice, however, the adapter will add less than one percent total harmonic distortion to the overall system.

The envelope wave produced by the adapter permits independent upper and lower sidebands to be demodulated by standard a-m detectors. Therefore, stereophonic reception can be achieved by simply tuning two receivers to the respective upper and lower sidebands.

Compatible monaural reception of stereo programs is accomplished by tuning a standard a-m receiver to the carrier in the usual manner. Both stereo channels can then be received without loss of program balance.

Fidelity

Improved audio fidelity in each of the stereo channels is a function of receiver bandwidth. Design economy requires that most receivers employ narrow-band i-f amplifiers, and the great majority have a total passband of only 5 or 6 kc.

When conventional a-m transmissions are employed, receivers must be tuned so that the carrier is centered in the i-f passband. Therefore, only one-half, or between 2.5 and 3 kc, constitutes the actual fidelity of these receivers. With a-m stereo reception, however, each set is tuned slightly off carrier so that the carrier appears on one side of the i-f passband, in the same manner as compatible single-sideband. Thus more of the i-f bandwidth of the receiver can be used, resulting in a marked improvement in audio fidelity, approaching that of f-m.

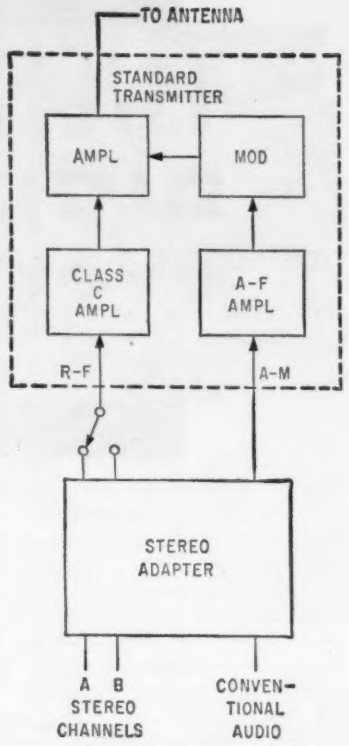
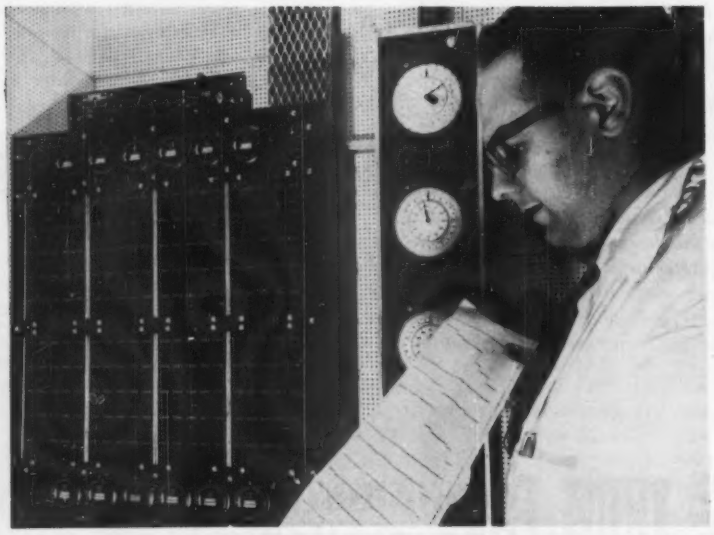


FIG. 1—Adapter is used with standard a-m transmitter

Electronics Tests Drug Reactions



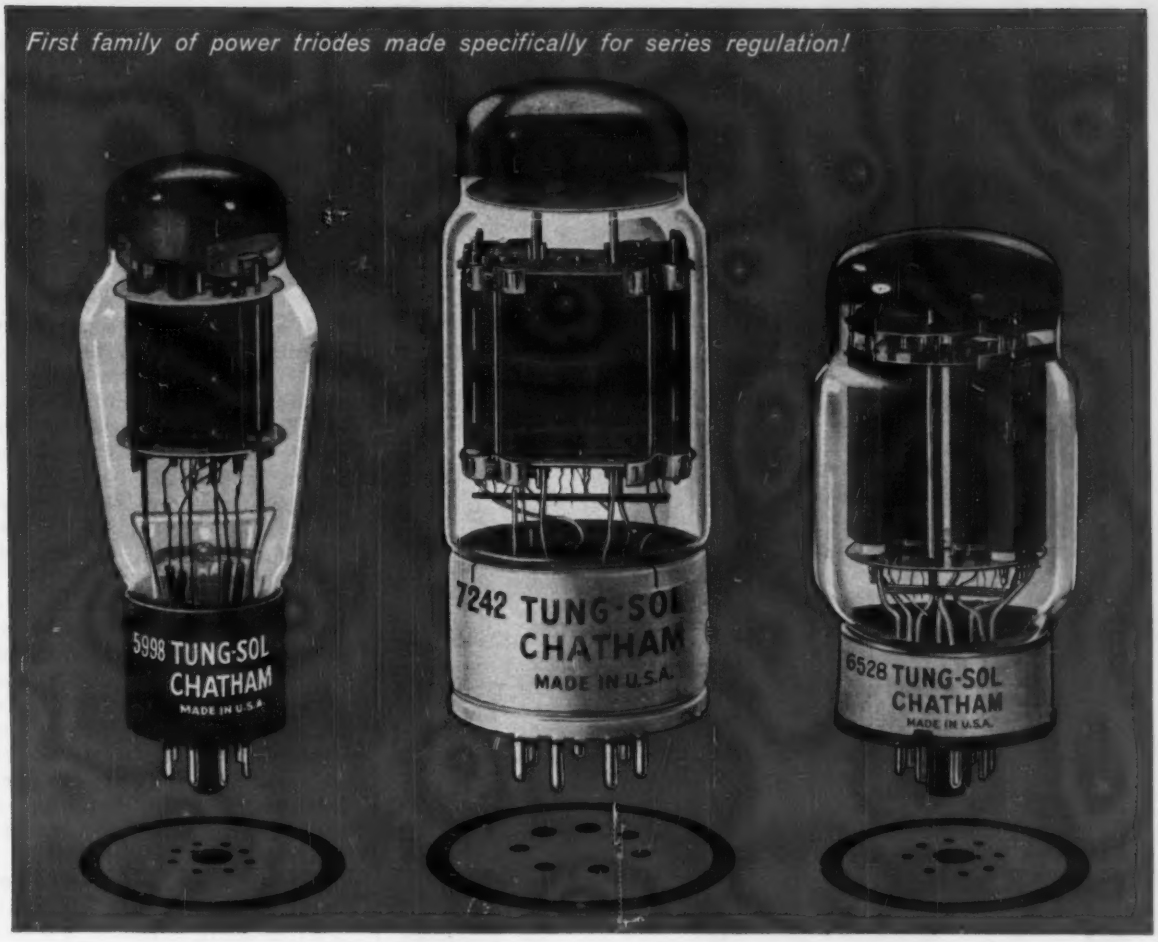
Performance of animals after being given new drugs is graphically recorded at Schering Corp. behavior laboratory. Landis & Gyr impulse counters show statistical pattern of behavior for comparison with behavior of same animal without drug

Instrument Makes Contour Maps

DRAWING contour lines showing ground elevations has been achieved in an instrument developed by the Photographic Survey Corp. Ltd. and other companies of Hunting Associates Ltd., Toronto.

Called Stereomat, the device re-

First family of power triodes made specifically for series regulation!



Tung-Sol/Chatham power triode family covers every series regulator need!

Now designers can specify a premium quality Tung-Sol/Chatham tube for all series regulator sockets. Tung-Sol/Chatham's family of power triodes — the first designed and produced specially for series regulator service — meets all design requirements and assures maximum reliability and life at all times.

Types include the new 100 Watters, 7241 and 7242, medium mu or low mu-high current. 12 or 26 Volt heater versions available on most types. All embody sturdy construction features that contribute to overall ruggedness and long hours of heavy-duty operation.

Compare the ratings below against your particular application! If you desire complete data sheets . . . or you have a specific design problem, contact us today! We'll be glad to give whatever assistance we can. Just write: Tung-Sol Electric Inc., Newark 4, N. J., Commercial Engineering Offices: Bloomfield and Livingston, N. J., Culver City, Calif., Melrose Park, Ill.

TYPICAL VALUES				
	Total Plate Current	Range of Tube Voltage Drop	Minimum Tube Drop	Grid Voltage Swing
[illegible]	200 ma	80 v	45 v	20 v
[illegible]	400	65	70	10
[illegible]	600	80	70	13

PERTINENT CHARACTERISTICS PER TUBE				
	Max. Plate Current	Max. Plate Voltage	MU	Gm
[illegible]	280	275	5.5	28,000 umhos
[illegible]	600	400	9.0	74,000 umhos
[illegible]	900	400	9.0	111,000 umhos

TUNG-SOL®

TUBE TYPES BY PLATE DISSIPATION RATINGS			
Total Plate Dissipation	26 to 30 W	60 W	100 W
[illegible]	6AS7G, 6082 6080WA, 7105	6336A 6394A	7241
[illegible]	5998	6528	7242

All the right connections for

CONTINUOUS PERFORMANCE

Continuous performance under extreme environmental conditions is yours with Deutsch 27-contact miniature connectors. These environmental performers exhibit thrilling qualities:

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Shimmy and shake these rugged connectors. They're vibration-dampened and withstand physical shocks up to 100 G's. The exclusive Deutsch ball-lock coupling ring ensures a positive lock without twisting or turning, without lock-wiring or coupling nut. Just push in to connect—pull back to disconnect.

To take a peek at the inside information on Deutsch 27-contact miniature connectors...as well as the 3, 7, 12, 19, 37 and 61 contact members of this environmental troupe...write for data file 4B.

The Deutsch Company

7000 Avalon Boulevard · Los Angeles 3, Calif.

places the human operator in establishing contours on photogrammetric maps made from aerial photography. In addition to civil and military mapmaking, it promises benefits for mining, heavy construction and other industries that require fast and accurate mapping service.

Other Applications

It is expected that some of the circuits developed for the system will find applications in communications, radar, submarine detection, missile guidance systems, and in geophysical instruments used for mining exploration.

Applications for defense purposes are being studied by Canadian and U. S. military research organizations.

The process of making accurate maps from aerial photographs involves determining elevations of ground points, so that contour lines showing the terrain relief can be drawn. Determination of relief is obtained on instruments called stereoplotters by viewing the common area between two overlapping aerial photographs taken from different positions in space.

Paralax along the base line between the two pictures (X paralax) is a measure of elevation. It is also necessary to remove components of paralax in a direction perpendicular to the base line (Y paralax).

Perceiving X paralax and removing Y paralax through relative orientation have been human functions. The operator of the stereoplotting instrument must be highly trained and have faultless depth perception. In addition, it is a slow and tedious task.

Operation

The stereomat attached to a conventional stereoplotter determines X and Y paralax at any point in the stereo model. It removes Y paralax during relative orientation automatically.

In the profiling mode, it corrects X paralax at all times by vertical movement of the projection platform, keeping an index mark on the terrain surface. This mark provides a continuous profile of the relief along any selected path in the stereo model as the index mark is

moved along the path in a horizontal plane.

In the contouring mode, elevation is held constant, and X paralax information is used to derive information for steering the index mark through the stereo model, producing contour lines.

The system identifies corresponding points in the two photographs of the same object taken from different positions. This is accomplished by scanning the area around each point with a spot of light. Varying light intensity resulting from boundary crossings in the photograph are converted to electrical signals by multiplier photo tubes.

Associated circuitry measures correlation of the electrical signals resulting from each photograph. The correlation is a measure of the common scanning area that is being searched. If the correlation is weak, the scanning pattern expands and vice versa. Thus points of image detail are identified by the context in which they appear.

After identifying the images, the new instrument determines the direction and magnitude of the paralax in both the X and Y directions separately.

The circuitry thus produces two d-c voltages, one for Y and one for X paralax. Polarity of the voltages depends on direction of the paralax and magnitude on amount of paralax.

Servos

The X paralax error voltage is fed to a servo that actuates the elevation of the projection table (index mark). When the error voltage becomes zero, the servo stops and the index mark is on the terrain surface.

The Y paralax error voltage is automatically switched to appropriate servo motors that in turn actuate the projection heads of the plotting instruments to remove Y paralax.

In the contouring mode, X paralax error voltage is combined with other information generated by the circuitry to actuate X and Y servos that move the index mark in the horizontal plane in the direction necessary to maintain the mark on a selected contour line.

NEW IDEAS IN PACKAGED POWER

for lab, production test, test maintenance, or as a component or subsystem in your own products

high-precision vapor fractometer gets Sorensen transistorized supply

provides *"better accuracy"* says Perkin-Elmer

Detector for Perkin-Elmer Model 154-C Vapor Fractometer (above) gets highly stable voltage from tiny but precise Sorensen dc supply (below). Dimensions are only 3-9/16 x 3-1/16 x 5 in.

Perkin-Elmer Corporation, Norwalk, Connecticut, selected a modified Sorensen miniature transistorized supply to build into the hot-wire detector unit for their new precision Model 154-C Vapor Fractometer.

They report they're pleased with the speed with which Sorensen modified their standard Model QM miniature voltage-regulated dc supply to fit their specialized requirements and they praised Sorensen's quick deliveries. But here's the statement we, at Sorensen, liked best:

The QM ". . . appears to afford even better regulation than Sorensen's specifications show (better than ±0.05% variation in output voltage for a 10% change in line voltage)." Need we say more?

Sorensen makes the widest line of transistorized power supply equipment on the market today—plus a complete line of electronic and magnetic-amplifier regulators for ac and dc, inverters, converters, and frequency changers, plus a complete line of extremely high-voltage equipment. Write for catalogs. And if you have a special problem or tough specifications to meet, ask the advice of your nearest Sorensen representative—he'll have the answer. 8-48

Sorensen

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Semiconductor Solid Circuitry

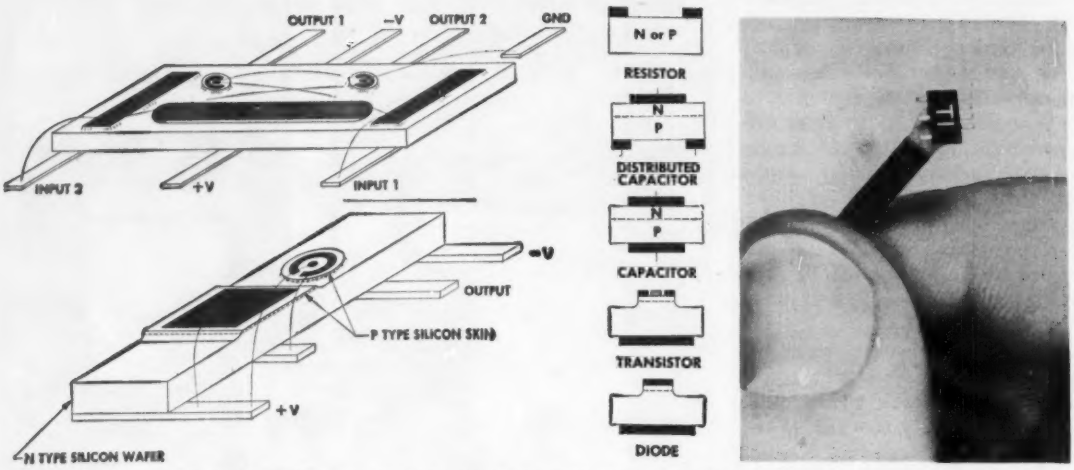


FIG. 1—All silicon, solid circuit multivibrator (top left). All silicon, solid circuit phase-shift oscillator (bottom left). Circuit elements (center). Resistor is formed by applying ohmic or nonrectifying contacts to a semiconductor wafer. Distributed capacitor is formed by combining the resistive and capacitive elements. Capacitor is formed by using capacitance of a relative large area of *pn* junction. Transistor uses diffused-base techniques as does diode. Solid circuit multivibrator shown on the head of match (right)

ONE OF THE MOST amazing assets of the electronics industry is its ability to avoid stagnation. This ability has been evidenced countless times through the years by originality, by doggedness and by patience. Just when a certain phase of the art seems to reach a plateau, a new path opens up for all to follow.

In recent months, there has been noticeable interest in what has been termed integrated molecular electronics—the combining of the passive functions of resistance, capacitance and inductance with the active function of amplification in a single, semiconductor solid circuit. Now, one manufacturer has announced publicly developmental models of such devices. The manufacturer is Texas Instruments.

Manufacturing Techinques

By using such semiconductor manufacturing techniques as controlled masking, etching and diffusion, Texas Instruments has formed diodes, transistors, resistors and capacitors as integral parts of single pieces of both silicon and germanium.

Two circuits, each less than $\frac{1}{4}$ by $\frac{1}{16}$ in., were demonstrated by the firm. The first is a multivibrator circuit, Fig. 1, containing the equivalent of 12 components—two diffused-base transistors, two capacitors and eight resistors. The second is an oscillator circuit, Fig. 1, containing the equivalent of nine components—five resistors, three capacitors and one transistor. By the usual measurements, these circuits represent a component density up to 34 million parts per cubic foot.

Application Areas

Solid circuits are expected to find ultimate usage mainly in applications where large numbers of repetitive circuits are required combined with low weight and size.

Figure 1 shows also how the different circuit elements are formed within the single semiconductor.

Reliability of solid circuits should be high for the following reasons: (1) Circuits, component equivalents and their connections are all integrated into the semiconductor material permitting predictable process controls. (2) Each circuit can be designed for a specific application and can be checked and tested functionally during the manufacturing process. (3) Electronic characteristics of each component equivalent can be tailored for the particular application in which the solid circuit will be used. (4) compared with a conventional circuit, up to 75-percent fewer connections are required.

The circuits described are strictly developmental and are not available, at this time, in either sample or production quantities.

Electronic Sardines Save Space

CONVENTIONAL leads and wiring are eliminated by welding components directly together giving a packing density of more than 100 components per cubic inch in another miniaturization approach unveiled by Raytheon. The company has likened the resultant package to a sardine sandwich.

Four elements make up the sandwich. First is the stick which is the component welded assembly. Next is the logic wiring, the terminations and the potting. In building the stick, a number of

after routing, clip and save

REFERENCE DATA FILE Folio 59-2

SANGAMO

a continuing series on technical topics of specific interest to engineers

How important are the functions of various impregnants in paper capacitors?

Capacitors using impregnated kraft tissue paper dielectric are available with a variety of impregnating materials. These materials are generally waxes, oils, or thermo-setting plastics. The electrical "personality" and capabilities of the completed capacitor is, in part, determined by the characteristics of the impregnant. The components application engineer must be familiar with the available materials in order to judiciously prescribe the proper component for a given application.

MINERAL OIL is an excellent electrical insulating medium. It possesses low electrical loss factor, is quite stable in dielectric constant over operating temperatures ranging from −65°C to +85°C and from low audio to radio frequencies. It exhibits extremely high dielectric strength and comparatively good insulation resistance characteristics. It is used to provide the operating conditions described as "E" characteristic in Military Specification MIL-C-25A.

ANOTHER SPECIAL IMPREGNATING OIL is used which is similar to mineral oil in physical and electrical characteristics, but is stabilized and purified to further improve the electrical characteristics and extend the operating temperature range to 125°C. This is supplied for "K" characteristic paper capacitors of specification MIL-C-25A. At Sangamo, the designation for this special impregnating oil is "Etherm".

CHLORINATED BIPHENYL is a synthetic oil that is manufactured under carefully controlled conditions of purity. Paper capacitors using this impregnant are often chosen for applications where fire hazards are a consideration because it is virtually non-flammable. Chlorinated biphenyl possesses a higher dielectric constant and provides an effective mechanism for decreasing the comparative size and cost of large value capacitors. It is used almost exclusively for impregnating capacitors designed for power frequency applications including those used for power factor correction in alternating current circuitry. This material is used to provide the "D" and "F" characteristics of MIL-C-25A. At Sangamo, the designation for Chlorinated biphenyl is "Diaclor".

A POLYESTER RESIN impregnant is a non-melting solid which is used where physically rugged capacitor sections of good electrical characteristics over an operating temperature range from −55°C to +85°C are desired. Its dielectric constant falls between that of chlorinated biphenyl and mineral oils and its capacitance stability during operating life is excellent. At Sangamo, the designation for polyester resin is "Resinex".

STABILIZED CHLORINATED NAPHTHALENE is a wax which is often used in light weight capacitors of minimum size where some sacrifice in electrical characteristics, such as lower insulation resistance at all temperatures and somewhat higher power factors can be tolerated and where an operating temperature range from −40°C to +85°C is acceptable. Its high dielectric constant results in light weight units of small size and provides the "H" characteristic operating requirements of MIL-C-25A. At Sangamo, the designation for stabilized chlorinated naphthalene is "Sangwax".

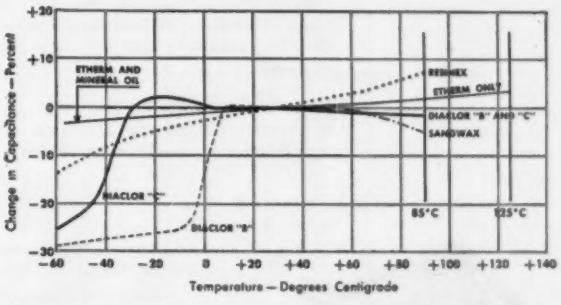
SILICONE IMPREGNANTS are chemically stable synthetic oils and are available over a wide viscosity range. They are used when extreme operating temperatures are specified and low dielectric losses are desirable. Silicone oils are liquid throughout their recommended operating temperature range.

Specification Guide Of The Various Impregnants Used in Sangamo Paper Capacitors

IMPREGNANT	SANGAMO CAPACITOR TYPE DESIGNATION
Mineral Oil	Type 50, 60, 70, 42 and 43
Etherm	Type SB, SD, SMB, SMD, 50K, 60K and 70K
Diaclor	Type 71, 50, 60, 40, 41, 75 and 80 (Referred to as can, oil paper, types)
Resinex	Type 33 (molded tubular)
Sangwax	Type 50, SA and SC

NOTE: With the exception of the Type 33 all of these capacitors are housed in hermetically sealed metallic containers. The Type 33 is molded in a thermo-setting non-hygroscopic plastic case. The "S" series types are housed in tin coated brass tubular containers with compressed glass solder seal ends. These units are most applicable where "High Reliability" is a necessity.

Engineering Catalogs Numbers 2421 and 2422 give full information and are available upon request for your files.



Composite curve of paper capacitors using five Sangamo impregnants for capacitance variations with temperature at 1000 cycles per second.

SC59-2

SANGAMO ELECTRIC COMPANY, Springfield, Illinois

--designing towards the promise of tomorrow

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- EXCELLENT MECHANICAL CHARACTERISTICS
- EXCELLENT ELECTRICAL PROPERTIES

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Quality-engineered Hickory Brand Electronic Wires and Cables are precision manufactured and insulated and sheathed in modern plastics.

Write for complete information on the full line of HICKORY BRAND Electronic Wires and Cables

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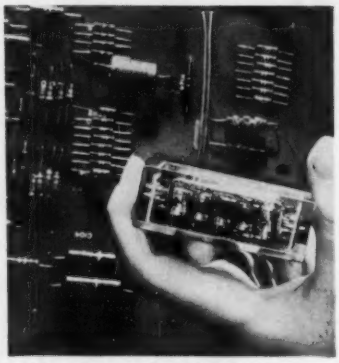
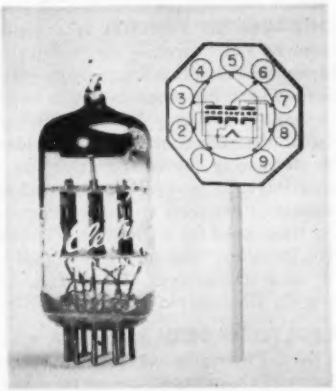


Electronic sandwich being held contains five times as many components as typical printed circuit in background

subassemblies are brought together with precision jigs and joined by a stored-energy welder. Layers of fine insulated wires form the interconnecting logic wiring. Molded terminal blocks with newly designed connectors are used and then the entire unit is potted.

Triple Triode Makes Debut

IN PRODUCTION at General Electric is a new idea in tubes— a triple triode. The 6EZ8 nine-pin miniature tube is capable of being used as a one-tube tuner for frequencies in the f-m band.

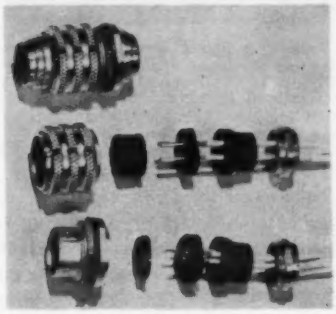


Cathodes of two of the three sections of the tube have a common connection with the cathode of the third section brought out to a separate pin. Each triode in the tube is rated as follows: plate volts, 330 max; negative d-c grid volts, 50; plate dissipation, two watts. In typical operation with

plate voltage of 125 and grid voltage of −1, each section has an amplification factor of 57, transconductance of 4,200 μmhos, and plate resistance of 13,500 ohms. Under these operating conditions, each section draws 4.2 ma.

One possible application for the new tube is its operation as a combined r-f amplifier, oscillator and mixer. Another might be used as a combined oscillator, mixer and afc tube.

Snap-In Connector Has Removable Contacts



CRIMP-TYPE terminations used in a new miniature snap-in connector manufactured by The Deutsch Company completely eliminate soldering. The new DS series is available in seven, 19 and 37 pin and socket arrangements with other sizes available shortly.

The connector offers continuous dielectric separation with no voids; is completely environmental up to 30 psi; withstands temperatures from −100 to +300 F and has a contact retention of 25 lb.

Heat-Resistant Plastic Available

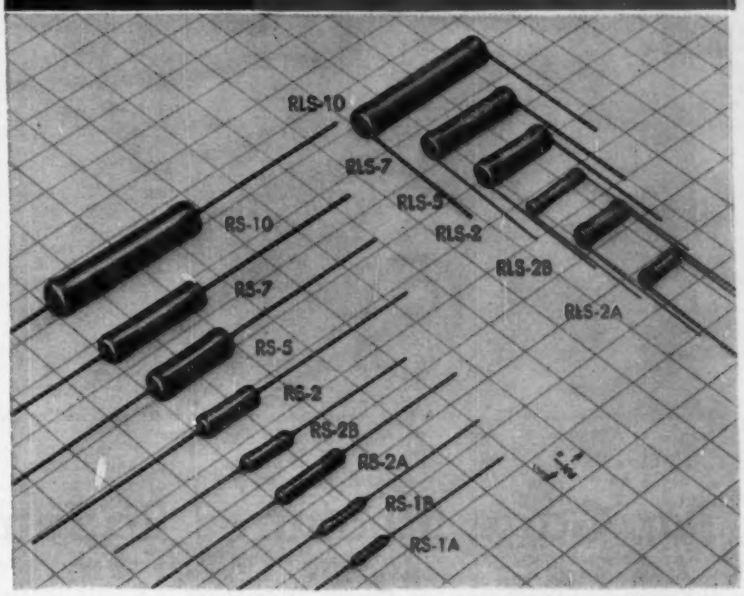
HIGH heat resistance, stiffness and toughness are combined in a new acrylic-type thermoplastic polymer.

Designated PL-12 by the J. T. Baker Chemical Co., the new plastic has a heat distortion point of 240 F, flexural modulus of 415,000 psi and fair transparency.

Injection molding and extrusion of the material can be done by conventional acrylic techniques.

DALOHM Ω

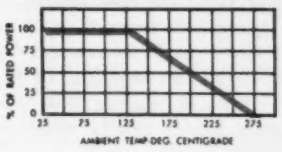
...for Complete Reliability Under Severe Environmental Conditions



TYPE RS, RLS POWER RESISTORS

Wire Wound, Precision, Miniature, Ruggedized

RS-2A DERATING CURVE



JUST ASK US

The DALOHM line includes precision resistors (wire wound and deposited carbon); trimmer potentiometers; resistor networks; collet fitting knobs and hysteresis motors designed specifically for advanced electronic circuitry.

If none of the DALOHM standard line meets your needs, our engineering department is ready to help solve your problem in the realm of development, engineering, design and production.

Just outline your specific situation.

DALE PRODUCTS INC.
1300 28th AVE.
COLUMBUS, NEBRASKA

Designed for the specific application of high power, coupled with precision tolerance requirements. Available with axial leads – RS TYPE; with radial leads – RLS TYPE (for printed circuitry).

Gives reliability under severe environmental conditions.

- Rated at 1, 2, 3, 5, 7 and 10 watts.
- Resistance range from 0.1 ohm to 175K ohms, depending on type.
- Tolerance: ±0.05%, ±0.1%, ±0.25%, ±0.5%, ±1%, ±3%.

TEMPERATURE COEFFICIENT: Within 0.00002/degree C.

OPERATING TEMPERATURE RANGE: −55° C. to 275° C.

SMALLEST IN SIZE: 3/32" x 13/32" to 3/8" x 1-25/32"

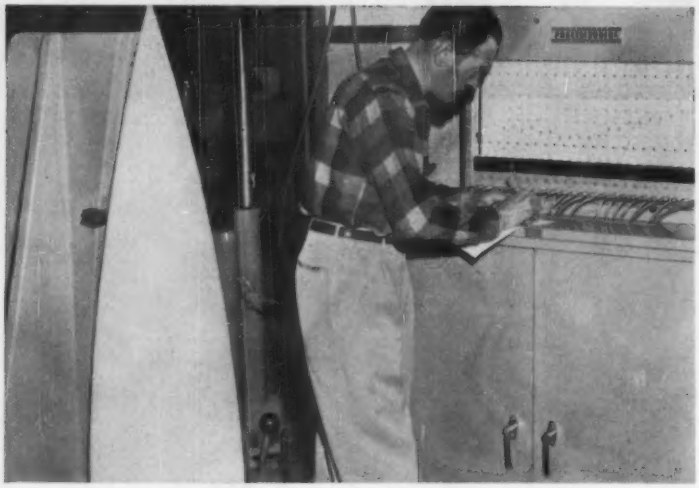
COMPLETE PROTECTION: Impervious to moisture and salt spray.

WELDED CONSTRUCTION: Complete welded construction from terminal to terminal.

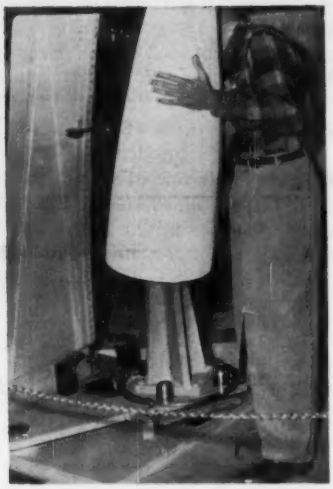
SILICONE SEALED: Offers maximum resistance to abrasion, and has high dielectric strength.

MILITARY SPECIFICATIONS: Surpasses applicable paragraphs of MIL-R-26C.

Write for Bulletins R-23, R-30



Thickness of radome at 23 points is read from position of metal floats positioned by air pressure. A total of 184 points is measured by rotating the radome



Radome is placed over retracted inner casting of fixture

Air Gage Measures Radome Walls

DIMENSIONAL INSPECTION of radomes for the Hawk missile is simplified with a precision air gage which measures radome wall thickness at 23 points in 1 step. The instrument was built for Raytheon Manufacturing Company's Hawk production plant, Andover, Mass., by The Sheffield Corp.

The gage consists of a gaging fixture and a columnar panel. To position the radome, or nose cone, a retractor is manually opened, the cone lowered over an inner casting and the retractor closed.

Both inner and outer castings of the fixture house a series of 23 small metal feelers which retract as the cone is positioned. Air pressure causes the feelers to gently hug the inner and outer surfaces of the cone.

The outer casting is mounted to the fixture's base. The inner casting is mounted on a swing arm pivoting from the base. The arm is moved to the right for loading and to the left, against a reference stop, for gaging.

Vertical glass columns are calibrated to show critical measurements on a flow graph. As each feeler assumes its position according to radome wall thickness, a small metal float actuated by air pressure moves to a corresponding position within a column.

Color coding on the graph indicates acceptable radome thickness tolerances. All floats must be within marked limits. Amount and location of variances are read directly from the flow graph.

Increments from 1 to 47 inches can be checked. By manually rotating the radome around the base of the stand, a total of 184 different gaging points can be measured in 8 steps.

Radome Correction

The radomes are constructed of laminated glass fiber cloth and resin. Domes with undersized wall thicknesses are returned to production for layup of additional laminas and then remachined. Domes with oversized thicknesses are machined down on a 25-inch Axelson tracer lathe.

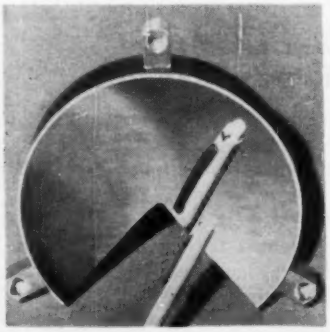
Air pressure in the gage ranges from 60 to 120 psi. Air flows upward through each internally-tapered glass column, actuating the metal floats. Air also flows out through plastic hosing to mating feelers. A filter cleans incoming air.

A proper relationship between radome wall thickness and dielectric constant is required for effective rf transmission. According to Raytheon, gaging time per radome is a few minutes, compared with about 2 hours formerly required with dial indicator gages.

Parts Can Be Molded Into Epoxy Mirrors

PARABOLOIDS, hyperboloids, ellipsoids and other complex surfaces for reflective components of infrared and other optical systems are being made of vacuum-plated cast epoxies by Singer Military Products Division, New York, N. Y.

Electrical and mechanical com-



Cut has been made in mirror to demonstrate machinability

CUT COSTS OF TEST EQUIPMENT BY 20% WITH Technical Information Service

Case histories have shown that companies waste up to 20% of their annual expenditures for test equipment.

A prime cause is the failure to make the best buy obtainable because each company did not know the full range of available equipment. Collecting and maintaining complete, timely, and accurate product information is difficult—could cost as much as $25,000 a year to service—and yet could be incomplete and inaccurate.

A prodigious number of crucial engineering and purchasing man-hours are squandered in test equipment procurement. Tracking down sources of supply takes days and, often, weeks. Key personnel are trapped by protracted correspondence and sales interviews while obtaining full specifications and prices. When modifications are involved, workloads increase geometrically. This costly routine must be repeated every time new purchases are made.

Now, for the first time, you can plug these hidden profit leaks through the use of a completely new concept in instrument evaluation for procurement.

Technical Information Service (TIS) provides you with complete, timely product information about *all* available electronic test equipment. In a matter of minutes you can possess detailed descriptions of equipment produced by every manufacturer in the business, from the largest to the smallest, without bias in favor of either. What's more, the descriptions include the *full specifications*, price, and the names and addresses of local sales representatives—all you need to initiate procurement.

Consider the benefits enjoyed by clients of Technical Information Service.

SINGLE SOURCE OF SUPPLY INFORMATION

Clients have the only central source of supply information designed specifically for their electronic test equipment requirements. Completely categorized, up-to-the-minute information makes the user a technical expert capable of quickly evaluating complete spec-by-spec comparisons of competitive equipment. Since TIS maintains accurate files by constant check of all sources for additions and changes in specifications and prices, clients may make inquiry by phone or letter on any test instrument problem at any time.

With such information at their fingertips, clients can make their purchases with total awareness of what the market has to offer. Procurement is made with minimal demands on key personnel and their time. Many clients find that this accelerated purchasing procedure has earned an extra bonus in expediting tight-schedule projects for which the test equipment is needed.

COMPLETE, ACCURATE INFORMATION

Clients receive detailed data on more than 4,500 separate instruments manufactured by some 400 different companies. Constant review of the entire instrument field by graduate engineers keeps data on specifications, prices, and models up to date at all times. Suppliers are queried on incomplete or dubious information, if necessary, before their products are included in any TIS release.

Since all products are described without charge and without advertising claims, small and large manufacturers are on equal footing. Their instruments speak for themselves with bald facts, free of slanted claims or persuasive case histories. Clients make their own evaluations from complete, factual information.

SUPPLIER RESEARCH SERVICE LOCATES "CUSTOM" INSTRUMENTS

Often, seemingly built-to-order requirements can be satisfied by minor modification to standard instruments. The complete listing of all large and small manufacturers of stock items provides a ready reference for such inquiry, either directly by the client or through the efforts of TIS.

In those cases where unique equipment is a necessity, TIS Supplier Research surveys the market for the client, collecting all the pertinent information he requires to initiate serious negotiations with suppliers.

COMPLETE PRIVACY

Whether TIS is locating sources for unique requirements or providing information on standard equipment, clients maintain a cloaked identity during all stages of inquiry. The Client conducts negotiations with the suppliers in whom he is interested.

FOUR-VOLUME DIRECTORY

Clients of the tax-deductible Technical Information Service receive a free, four-volume, handsomely bound encyclopedia of standard equipment and sources published twice a year and supplemented constantly. Three volumes are devoted to descriptions of equipment. The fourth volume is an extensive cross-index of manufacturers and their representatives. Completely free of advertising, the directories give clients a complete, factual picture of all standard electronic test instruments. Clients of Technical Information Service receive both the Directories and Supplier Research Service.

PROVEN IN USE

For the past two years TIS has served such clients as General Electric, M.I.T., Lincoln Labs., General Motors, NASA, Litton Industries, Naval Ordnance Lab., Hewlett-Packard, Lockheed Aircraft, Western Electric, RCA, Marconi Instruments, Eglin AFB, American Bosch Arma, and hundreds of others. The merit of TIS is proven by the fact that many clients have contracted additional service for other departments and projects.

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CIRCLE 56 READERS SERVICE CARD

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ponents, mounting brackets and other parts can be molded into the mirror's epoxy backing. Other advantages reported by the firm include a high rate of production, machinability, controlled density and high resistance to thermal shock.

An epoxy negative, cast from a precision ground glass master mirror is used as a mold for the epoxy backing. An aluminum reflective coating is vacuum plated on the backing and overcoated with a protective film.

Standardized CRT Disk Cathode Measurement

Method of using air gage to measure critical dimension of cathode

STANDARDIZED TECHNIQUES for measuring the distance from cap surface to ceramic on crt disk cathodes are proposed for industry adoption by Superior Tube Co., Norristown, Pa. Air and mechanical gages can be employed.

Objective of the proposal is to end producer-customer discrepancies in the measured distance, called the E dimension by the firm (Fig. 1). The dimension controls spacing between the cathode's emitting surface and the control grid, controlling in turn the amount of cutoff voltage.

All disk cathodes made by the firm are checked to a tolerance of 0.0005 inch in the E dimension. In addition, customers make quality control checks. Measurements are customarily made with identical types of mechanical gages.

An extensive investigation into E dimension measurements revealed that 2 identical mechanical dial gages, mounted side by side and calibrated with the same precision gage blocks, many times gave different results when measuring the same cathode.

The disk-shaped caps can be de-

CIRCLE 57 READERS SERVICE CARD

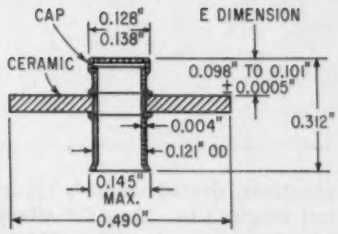


FIG. 1—Standard disk cathode showing E dimension. Tolerances of other dimensions vary from 0.0005 to 0.010 inch

pressed with a slight amount of pressure due to their lightness. Spring pressure found in dial gage mechanisms, according to the firm, is in most cases ample to depress the disk, giving an E reading less than the actual dimension when pressure is removed. Differences in spring pressure from gage to gage introduce false readings.

In the new system, cathode samples are air gaged and used as secondary standards for calibrating measuring instruments, correlating manufacturer's and customer's results. The readings for cathodes which are within tolerance are recorded and the cathodes are used as masters by both producer and customer.

With a master in place on a mechanical gage, the dial is set to read the exact E dimension previously determined by air gage. Whatever amount the cap is deflected is disregarded. Tests have shown that any mechanical dial gage can be accurately calibrated by this measurement.

This method is considered a secondary solution by the firm, intended to preserve the utility of the many existing mechanical gages used for this purpose.

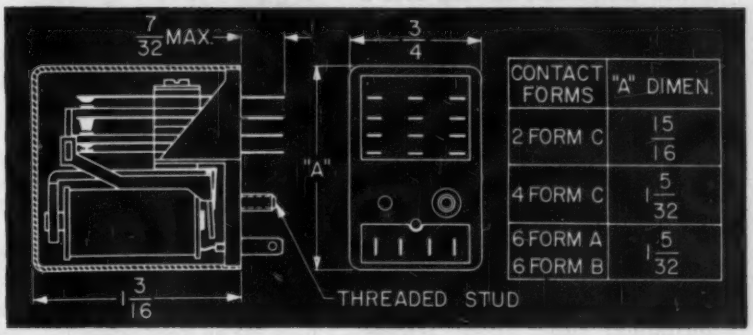
Air gages are considered preferable since there is no mechanical contact with the disks and the air pressure is not sufficient to deflect the disk. If the disk is concave, an average dimension is recorded since the stream of air covers the entire surface of the cap rather than high or low spots.

Other advantages cited are faster readings, less mechanical maintenance, only 1 calibration per work day and air gages do not require different adapters for various sizes of cathodes.

MINIMUM SIZE
Maximum Dependability
LOW COST

ACTUAL SIZE

The new T-154 relay is now being manufactured by Allied Control at Plantsville, Conn.



CONTACT FORMS	"A" DIMEN.
2 FORM C	15/16
4 FORM C	1 5/32
6 FORM A 6 FORM B	1 5/32

General Features:

Operate Sensitivity:
From 90 milliwatts for 1.3 ohm coil to 160 milliwatts for 15,000 ohm coil up to 2 Form C

From 200 milliwatts for 1.3 ohm coil to 400 milliwatts for 15,000 ohm coil up to 6 Form A

Coil Resistance: Up to 15,000 ohms

Coil Voltage: Up to 140 volts d-c

Contact Rating:
Low Level to 1 ampere 29 volts d-c or 115 volts a-c resistive. 5 ampere contacts are available

Contact Arrangement: Up to 6 Form A, B and 4 Form C

Operate and Release Time: 7 milliseconds max. at 1 watt

Shock: 10 g's

Vibration: 10 to 55 cps at .062" double amplitude

Enclosure: Dust proof and hermetically sealed

For complete information write for Bulletin T154

ALLIED CONTROL

ALLIED CONTROL COMPANY, INC., 2 EAST END AVENUE, NEW YORK 21, N. Y.

AL 193

ON THE MARKET

Time Delay Relays subminiature

DIALTRON CORP., 203 Harrison Pl., Brooklyn 37, N. Y., announces a line of subminiature time delay relays designed for high-altitude, high-vibration, and high-temperature applications. Seated height is $1\frac{3}{32}$ in., and weight $\frac{3}{4}$ oz. They are offered in a time range from 1 to 300 sec and in heater voltages up to 150 v interchangeable on d-c or a-c of any frequency with a power drain of 4 w. **Circle 200 on Reader Service Card.**

Phase Generator 5-200,000 cps

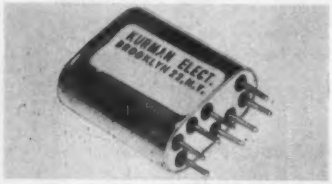
DYTRONICS CO., 78 Sunnyside Lane, Columbus 14, Ohio. Model 410 is a new instrument offering both a phase shifter and a phase difference generator. It covers a frequency range from 5 cps to 200,000 cps. By addition of an external capacitor the l-f limit can be extended below 0.1 cps thus giving an effective frequency range from 200,000 cps to below 0.1 cps. Accuracy over a-f spectrum is 0.1 deg with decreasing accuracy above and below the audio range. **Circle 201 on Reader Service Card.**

D-C Voltmeter four-and five-digit

CUBIC CORP., 5575 Kearny Villa Road, San Diego 11, Calif. Four- and five-digit d-c voltmeters are announced. They feature transistorization; clear, bright readout with edge-lighted numerals one inch high; controlled drive of stepping switches, in which the switches turn themselves off part way through their cycle, coasting to a stop and thus preventing overdrive and minimizing impact wear. **Circle 202 on Reader Service Card.**

Push Button Switch locking type

RICHARDS ELECTROCRAFT, INC., 3743 N. Kedzie Ave., Chicago 18, Ill. A new line of locking type push button switches mount easily on $\frac{3}{8}$ in. centers. They are ruggedly constructed with plated steel frames. Contact leafs are of nickel silver, contacts of fine silver. Switches are available in standard 3 ampere rating. **Circle 203 on Reader Service Card.**



Relay microminiature

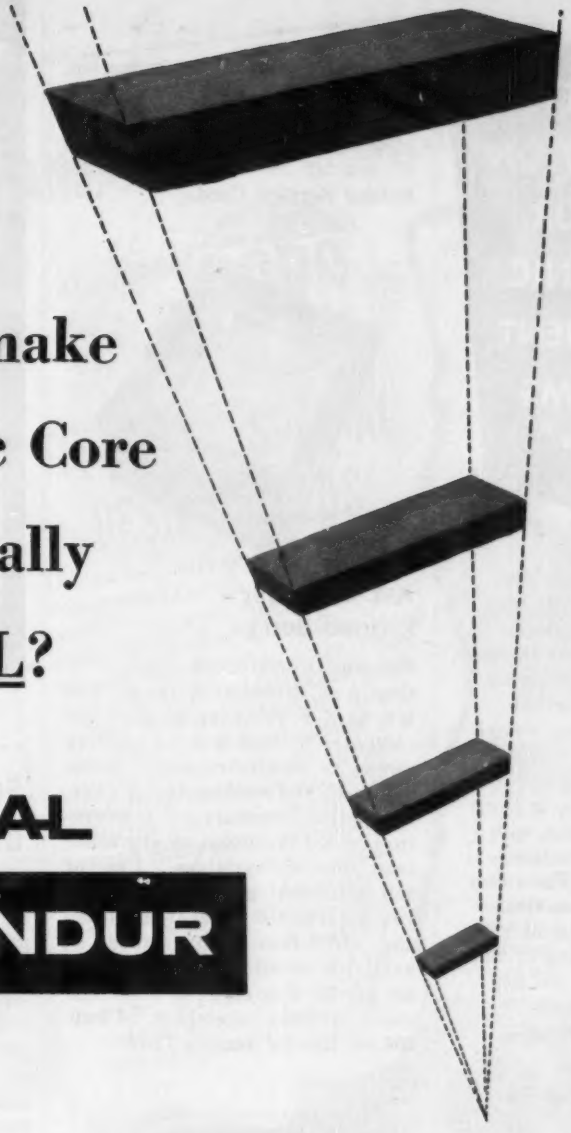
KURMAN ELECTRIC CO., 191 Newel St., Brooklyn 22, N. Y. Model KX relay measures 0.4 in. wide by 0.8 in. long by 0.875 in. high. Features include: operating temperature range, −65 C to +125 C; sensitivity of 200-250 mw. Relay will withstand shock tests of 50 g's; vibration frequency of 20 to 2,000 cps, at 20 g's. **Circle 204 on Reader Service Card.**

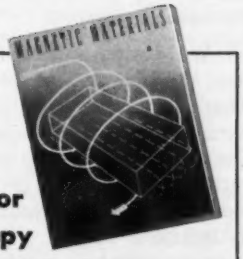
Audio Transistors medium power

BENDIX AVIATION CORP., Long Branch, N. J. Designed for use as a power transistor driver, the new 2N1008, A, B transistor series has many applications to Class A and B amplifiers, audio oscillators, relay drivers, servo controls and

How to make a Magnetic Core that's really SMALL?

use AL PERMENDUR





Write for your copy "MAGNETIC MATERIALS"

This 32-page book contains valuable data on all Allegheny Ludlum magnetic materials, silicon steels and special electrical alloys. Illustrated in full color, includes essential information on properties, characteristics, applications, etc. Your copy gladly sent free on request.

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When the conditions of service make it imperative for you to hold the size and weight of magnetic cores at an absolute minimum, that's the place to use Permendur. With it you can push the flux density up to 20 kilogausses, and practically eliminate weight as a consideration.

Along with its suitability for cores wherever the premium is laid on compactness, Permendur is just the thing for sonar magnetostriction applications, too. We maintain proper annealing facilities for this alloy. Write for technical data on it, and let our engineers help you to cash in on its possibilities.

In addition to Permendur, we offer a range of high-permeability alloys, oriented silicon steels and other electrical alloys that is unmatched in its completeness. Our services also include the most modern facilities for lamination fabrication and heat treatment.

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RELIABILITY... THE SOLUTION TO YOUR ELECTRONIC COMPONENT PROBLEMS

Designing reliability into electronic components and instrumentation is Borg Equipment Division's business. Borg's reliable engineering, research and production facilities are at your service for commercial or military projects. Bring your component reliability problems to Borg. You'll enjoy working with our cooperative, creative engineering staff. The result will be a sound, practical and reliable solution at a considerable saving of time and money. Here are just a few of the products manufactured by Borg . . .

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- AIRCRAFT INSTRUMENTS
- POTENTIOMETERS
- MULTI-TURN COUNTING DIALS
- FRACTIONAL H. P. MOTORS
- SPECIAL DESIGNS

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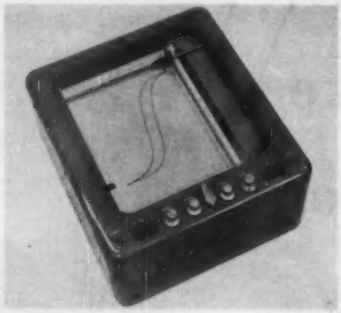
BORG — Built by Borg

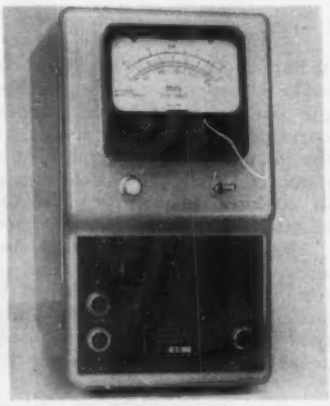
BORG EQUIPMENT DIVISION
Amphenol-Borg Electronics Corporation
JANESVILLE, WISCONSIN
CIRCLE 60 READERS SERVICE CARD

medium level audio amplification. Contained in the JEDEC TO-9 package, the transistor is capable of dissipating 400 mw at 25 C and 67 mw at 75 C. **Circle 205 on Reader Service Card.**



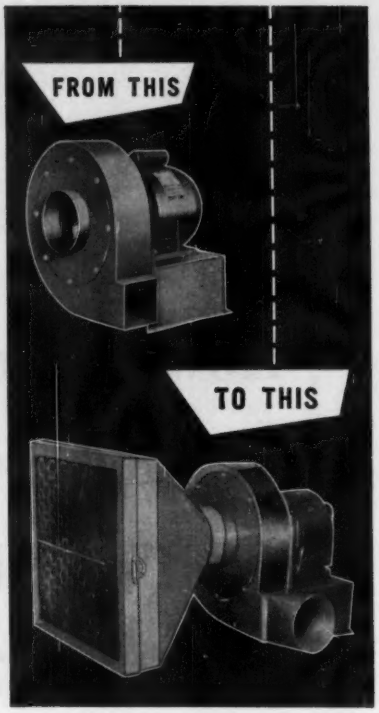
X-Y Recorder
Rugged design

HOUSTON INSTRUMENT CORP., 1717 Clay Ave., Houston 3, Texas. The HR-92 X-Y recorder is used for computer readout and for plotting stress vs strain, magnetic material, tube and semiconductor characteristics, pressure vs temperature, speed vs torque, or any other two related variables. Use of self-balancing potentiometer servos assures 0.5 percent accuracy and drift-free performance at available sensitivities of up to 1 mv per in. Pen speed is 1 sec full scale without overshoot. **Circle 206 on Reader Service Card.**



Differential VTVM
3 percent accurate

MILLIVAC INSTRUMENTS DIVISION of Cohu Electronics, Inc., Box 997,



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We design and build our own fans and blowers . . . motors and all. That's why we unconditionally guarantee their dependable performance. Our engineers work to your specifications to produce the fans and blowers that enable your equipment to operate at its best.

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CIRCLE 61 READERS SERVICE CARD

STANDARD COMPONENTS

built by **BORG**®

FIT MANY SPECIAL DESIGN NEEDS

Design flexibility of standard Borg components often eliminates the need for expensive, specially designed units. Borg offers a complete line of precision potentiometers, turns-counting dials and fractional horsepower motors. Many of these standard Borg components are currently on duty in missile launching platforms and firing control stations, radar and sonar equipment, computers and similar electronic apparatus. Production of standard Borg components assures quick delivery. A partial selection is shown on this page. Write for complete data on all Borg components. Ask for catalog BED-A90.

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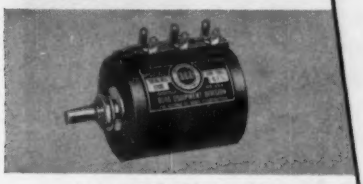
SIZE: 1¾" dia.; 2⅛" long; shaft extension ⅞" or special to order.

LINEARITY ACCURACY: ±0.1% and 0.05% (independent or zero based).

RESISTANCES: 50 ohms to 100,000 ohms, tolerance ±5%.

POWER DISSIPATION: 5 watts at 40° C.



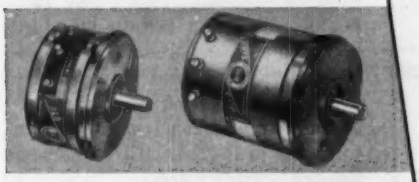
1100 SERIES, 10-TURN MICROPOTS

SIZE: 1⅞" dia.; 2⅛" long; shaft extension ⅞" or special to order.

LINEARITY ACCURACY: 0.5% to 0.1% (independent linearity).

RESISTANCES: 50 to 100,000 ohms, tolerance ±5%.

POWER DISSIPATION: 3 watts at 40° C.



900 SERIES MICROPOTS

Borg 900 Series Micropots are available in single-turn, 3-turn and 10-turn models.

SIZE: Single-turn — 2" dia.; 1$\frac{5}{64}$" long
3-Turn — 2" dia.; 1⅝" long
10-Turn — 2" dia.; 2$\frac{1}{16}$" long
Shafts — ¼" dia.
Bushing Mount — ⅞" long
Servo Mount — ⅝" long

LINEARITY ACCURACY: Single-turn — ±.5% (independent)
3-Turn — ±0.1% (independent, zero based, or absolute reference).
10-Turn — .05% (independent, zero based, or absolute reference).

RESISTANCES: Single-Turn — 50 to 50,000 ohms
3-Turn — 15 to 60,000 ohms
10-Turn — 50 to 300,000 ohms

TEMPERATURE LIMITS: Tested to 350° F.

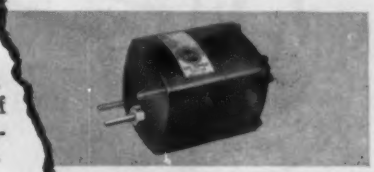
990 SERIES TRIMMING MICROPOTS

SIZE: 1¼" x $\frac{5}{16}$" x $\frac{17}{64}$"

RESISTANCES: 10 to 30,000 ohms standard. Other values on special order.
Tolerances — ±5% 100 ohms and over
±10% below 100 ohms

ADJUSTMENT: Screw driver slot provides adjustment of complete range in 40 turns.

TERMINALS: Printed circuit, soldered lug, insulated wire leads.



PRECISION INSTRUMENT MOTORS

Borg-Motors offer you fractional horsepower motors in synchronous or induction models with or without gear-trains in 2-pole or 4-pole models for your precision equipment. Borg-Motors are totally enclosed, using precision machined die cast alloys for end bells and gear train cases. Die cast rotors, mounted on two ball bearings, assure long life, continued accuracy.

DIRECT READING MICRODIALS

Borg Direct-Reading Microdials provide the highest accuracy of perception when forced-fast-reading and setting is required because of their inline digital presentation. Borg Direct-Reading Microdials are available in 3-digit 10-turn models, 4-digit 100-turn models and 5-digit 1,000 turn models. Also available are Borg Concentric Scale Microdials which indicate the position of any multi-turn device of 10 turns or less.

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BORG EQUIPMENT DIVISION
Amphenol-Borg Electronics Corporation
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- MICRODIALS
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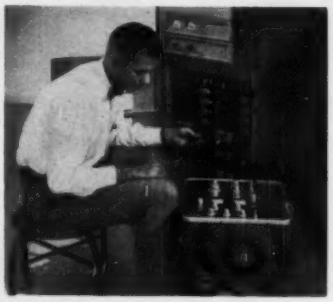
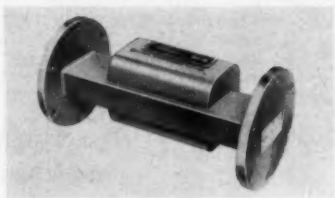
Schenectady, N. Y. The MV-212C a-c differential vtvm is designed for differential measurements from 0.7 mv to 300 v, in the frequency range from 20 cps to 500 kc. Dual range attenuators are provided. They are easily balanced by a common mode rejection control for common mode rejection rations up to 100:1. **Circle 207 on Reader Service Card.**



Calibration Unit all-semiconductor

AMPEX CORP., 934 Charter St., Redwood City, Calif., has introduced a fully portable, all-semiconductor device intended for precision alignment and calibration of electronic equipment such as f-m record/reproduce systems. The TC-10 calibrator contains a voltage standard accurate to 0.01 percent. Nine precision oscillators and seven binary dividers provide 63 accurate calibration frequencies ranging from 1,012 cps to 151.2 kc. **Circle 208 on Reader Service Card.**



Ferrite Isolators three models

POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC., 202 Tillary St., Brooklyn 1, N. Y., announces a new line of ferrite isolators. Covering the frequency range from 3.95 to 12.4 kmc in three broadband models, they have an insertion loss of

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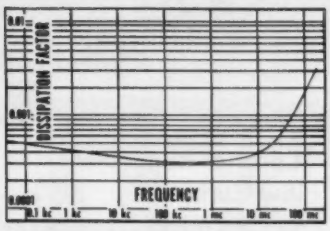

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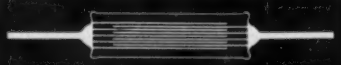

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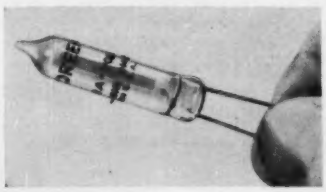

Corona Regulators low current

THE VICTOREEN INSTRUMENT CO., 5806 Hough Ave., Cleveland 3, Ohio. Type GV3A-700L corona type regulator tube, for operation at 700 v and for currents of 0.001 μa or higher, provides an attractive form of voltage regulation for many applications requiring economy of current drain from the primary power source. **Circle 210 on Reader Service Card.**

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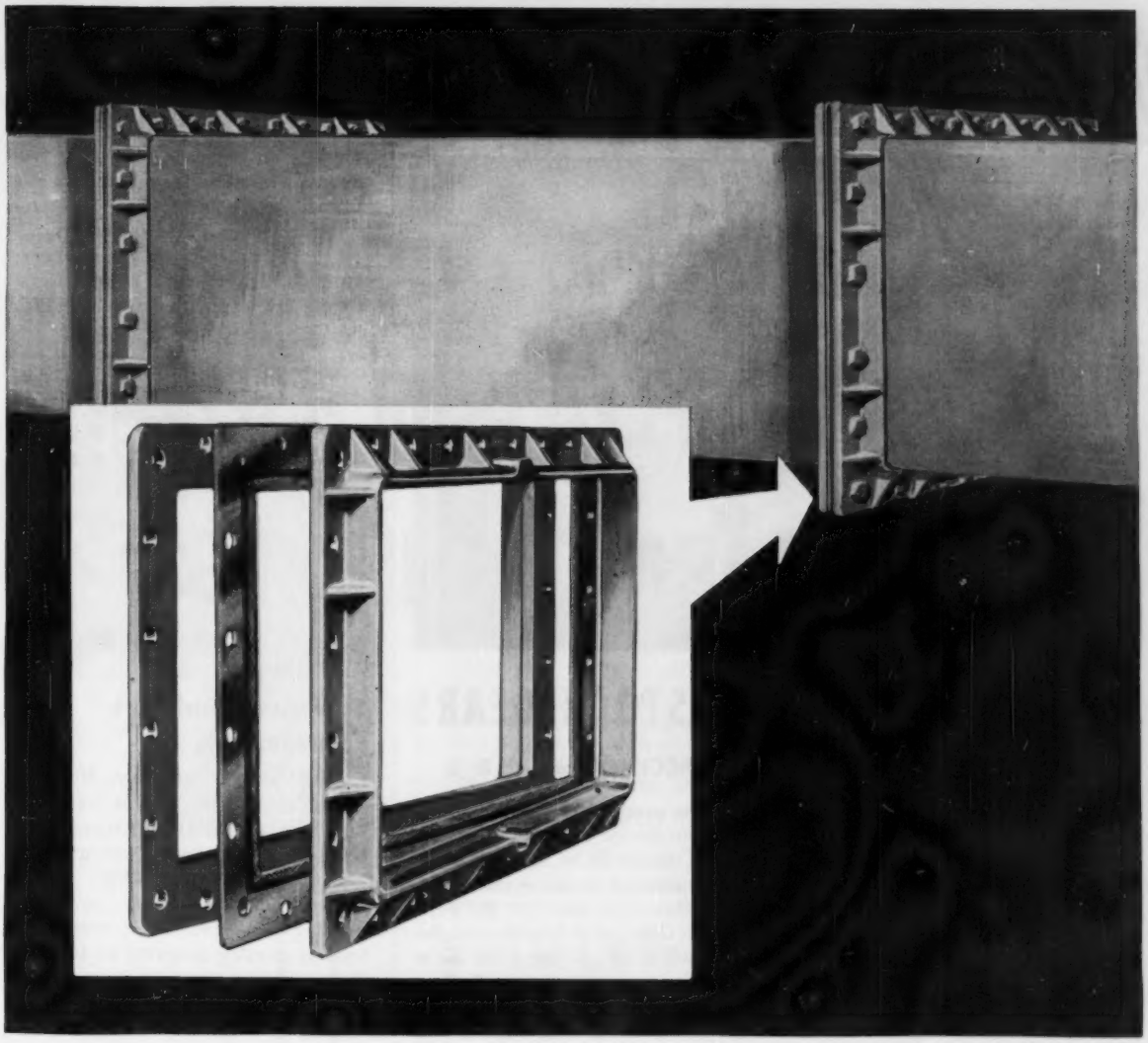
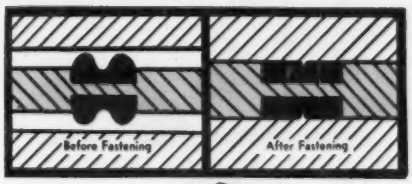
THE GERBER SCIENTIFIC INSTRUMENT CO., 89 Spruce St., Hartford 1, Conn. Model TP007200B variable scale is a manually operated mechanical device. It saves much time in the reading of records such as oscillograms or telemeter data, because to a large extent it eliminates the drudgery involved in data reduction. It also saves time in the plotting of graphs and curves, especially in the direct multiplication and division of graphical functions and the reading thereof. **Circle 211 on Reader Service Card.**

VHF-UHF Calibrator wide frequency

CONTROL ELECTRONICS CO., INC., 10 Stepar Place, Huntington Station, L. I., N. Y., announces a vhf-uhf calibrator which covers the spectrum from 50 mc to 11,000 mc



THESE WR WAVE GUIDE SEALS PROVIDE POSITIVE SEALING; PREVENT R/F LEAKAGE, ARCING & BURNING



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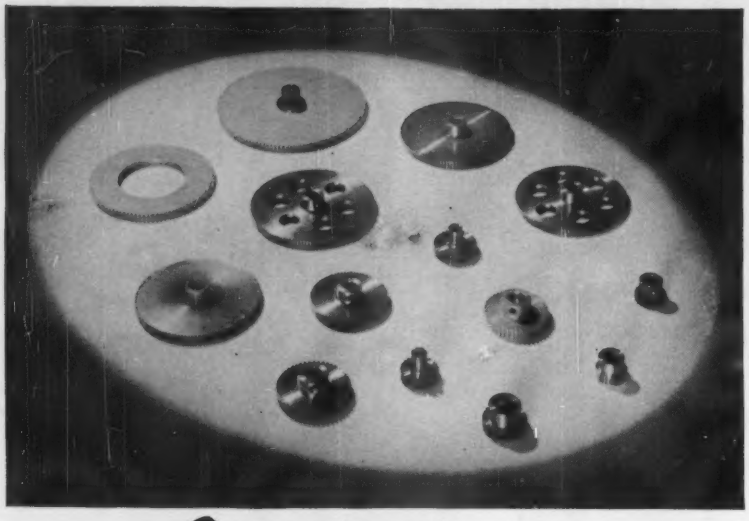

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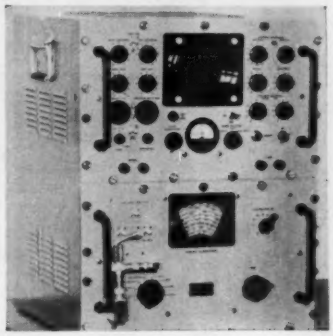
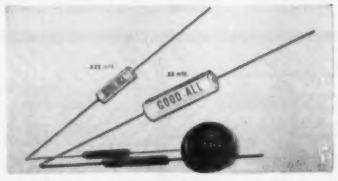


Spectrum Analyzers versatile units

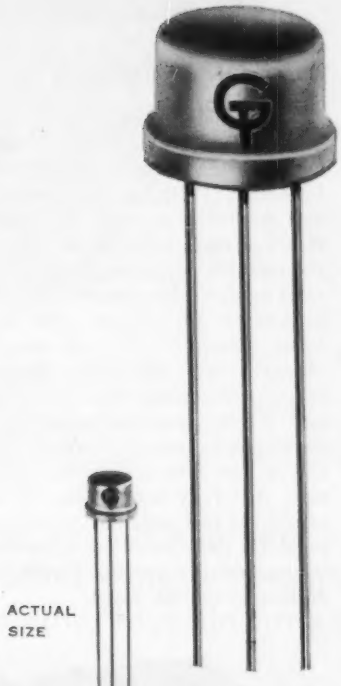
LAVOIE LABORATORIES, INC., Morganville, N. J. The use of external detachable coaxial and waveguide mixers in two new spectrum analyzers, models LA-18M (illustrated) and LA-20M, provides greater sensitivity and more extensive range calibrated to 44 kmc. Frequency calibration is accurate to ±0.1 percent at operating frequency of local oscillator, and the units have a sweep repetition rate of from 0.5 to 30 cps free running or synchronized. **Circle 213 on Reader Service Card.**



Tiny Capacitors 50-volt

GOOD-ALL ELECTRIC MFG. CO., Ogallala, Nebr. For transistorized circuits where space is critical, four new series of 50-v subminiature capacitors have been released. All are metal enclosed, hermetically sealed designs. They are available in tolerances to ±1 percent. Types

NEW HIGH VOLTAGE NPN TRANSISTORS ALLOW TUBE REPLACEMENT AND CIRCUIT COMPATIBILITY



ACTUAL SIZE

GT's new high voltage germanium alloyed junction transistors now allow the same optimization as formerly could be realized only with vacuum tubes. These characteristics plus conventional "transistor" advantages offer new design opportunities in computers, magnetic memory cores, data processing equipment, gas filled indicator tubes and other applications where reduction of space, weight and high reliability are prime requisites.

The GT 1200 is particularly suited to drive gas filled display tubes, such as the Burroughs Nixie ® and Pixie ®, without changing existing circuitry other than altering voltages so as not to exceed the rating of the transistor.

		GT 1200
Collector to Base Voltage (Emitter Open)	$I_C = 25\ \mu A$	90 Volts Min.
Emitter to Base Voltage (Collector Open)	$I_E = 25\ \mu A$	20 Volts Min.
Collector to Emitter Voltage (Punch Through)	$I_E = 25\ \mu A$	90 Volts Min.

Supplied in TO-9 case

GT 1201 – GT 1202, in addition to driving gas filled display tubes, are ideally suited for driving high inductance loads, driving transformer coupled loads and allow more nearly perfect impedance matching. These transistors are fast devices capable of handling high impedance loads and large signal swings.

		GT 1201	GT 1202
Collector to Base Voltage (Emitter Open)	$I_C = 25\ \mu A$	75 Volts Min.	45 Volts Min.
Emitter to Base Voltage (Collector Open)	$I_E = 25\ \mu A$	20 Volts Min.	20 Volts Min.
Collector to Emitter Voltage (Punch Through)	$I_E = 25\ \mu A$	75 Volts Min.	45 Volts Min.

Supplied in TO-9 case

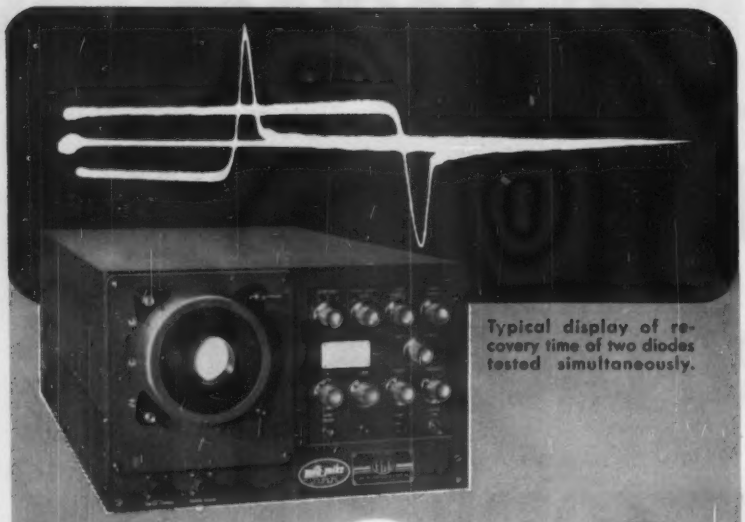
Write today for Bulletin GT 1200. Nixie® and Pixie® are registered trade marks of Burroughs Corporation

GENERAL TRANSISTOR

C O R P O R A T I O N

91-27 138TH PLACE JAMAICA 35, NEW YORK

IN CANADA: BESSER E-E LTD., 441 ST. FRANCIS XAVIER, MONTREAL 1, QUEBEC. FOR IMMEDIATE DELIVERY FROM STOCK, CONTACT YOUR NEAREST AUTHORIZED TRANSISTOR DISTRIBUTOR OR GENERAL TRANSISTOR DISTRIBUTING CORP., 91-27 138TH PLACE, JAMAICA 35 NEW YORK. FOR EXPORT: GENERAL TRANSISTOR INTERNATIONAL CORP., 91-27 138TH PLACE, JAMAICA 35, NEW YORK.



Typical display of recovery time of two diodes tested simultaneously.

2 FROM 1

GET DUAL POSITION OPERATION FOR QUALITY CONTROL TESTING OF FAST RECOVERY DIODES WITH THE

EG&G MILLI-MIKE OSCILLOSCOPE

Now two operators can use the same EG&G Type 2236A Milli-Mike Oscilloscope at the same time. It's like getting **two** oscilloscopes—**(EG&G Oscilloscopes)**—for the price of **one!**

TYPE 2236A PERFORMANCE DATA

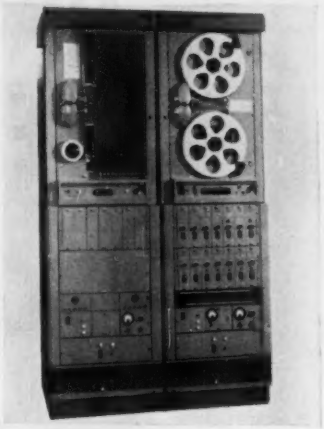
	Vertical (TW)	Horizontal
Sensibility	.054 v/trace width	0.30 v/trace width
Nominal Spot Size (trace width)	0.002 inch	
Deflection	27 v/inch (nominal)	150 v/inch
Frequency Response	DC to greater than 3,000 mc (—3db at approx. 2,000 mc)	
Input Impedance	50 or 100 ohms	
Writing Speed	3 x 10" trace widths/sec.	

The EG&G Milli-Mike Oscilloscope—one of a family of millimicrosecond instruments—is now being used to solve problems in measurement of high speed semiconductors, decay times of scintillators, discontinuities in transmission lines and as a synchroscope in high resolution radar systems. For information on this and other millimicrosecond pulse techniques, write to Application Engineering Group.

milli-mike **EDGERTON, GERMESHAUSEN & GRIER, INC.**

160 BROOKLINE AVENUE, BOSTON 15, MASS. 1622 SOUTH "A" STREET, LAS VEGAS, NEV.

626 G and 627 G are of extended foil construction. Types 628 G and 629 G employ tab construction. All are designed for operation at 85 C without derating and to 125 C with 50 percent derating. **Circle 214 on Reader Service Card.**

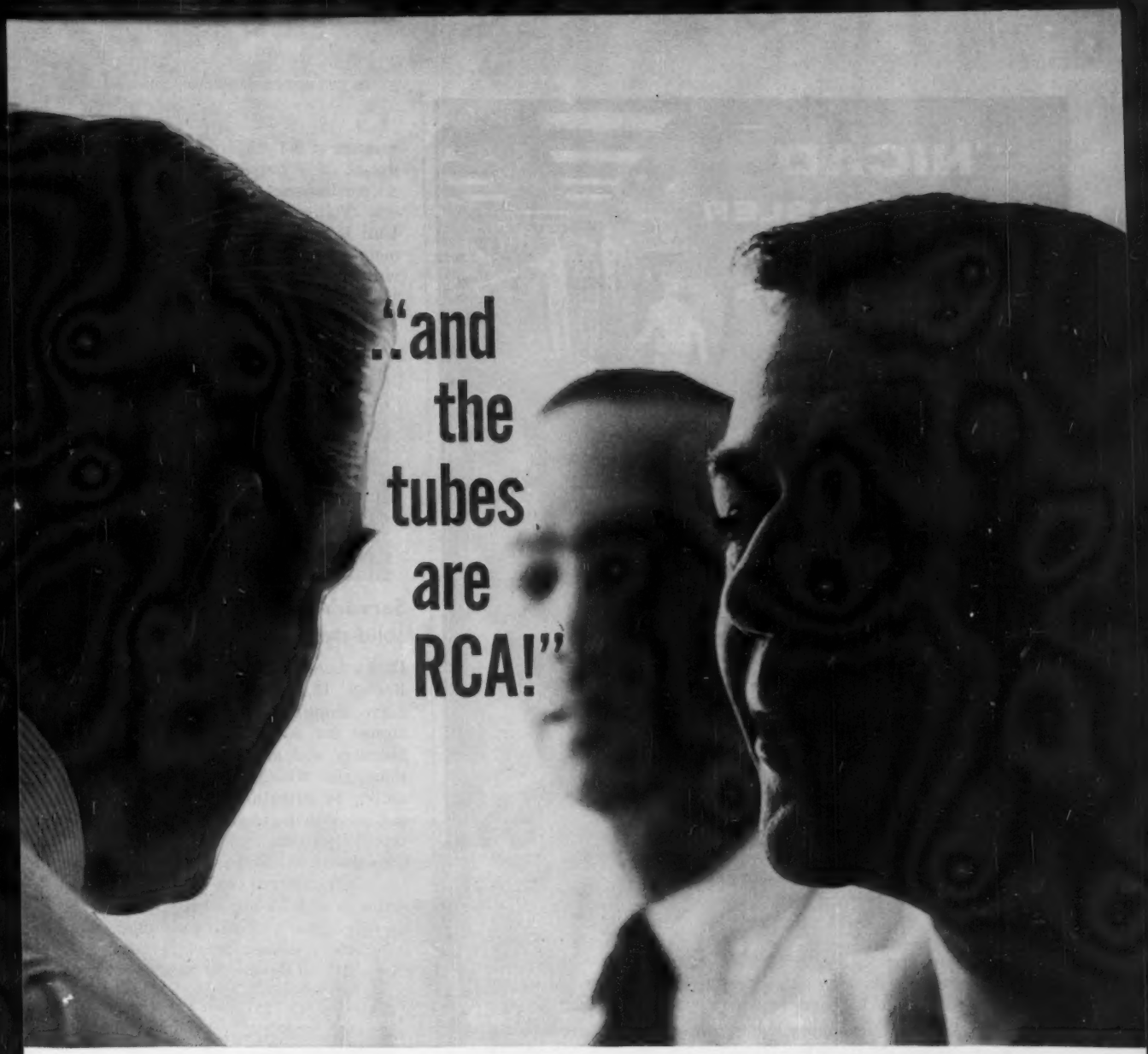


Recorder/Reproducer closed-loop

CONSOLIDATED ELECTRODYNAMICS CORP., 300 N. Sierra Madre Villa, Pasadena, Calif., has available a new magnetic tape continuous-loop recorder/reproducer designed for the repetitive study of highly transient data, random occurrences, and time-delay application. The type 5-781 (shown at left), a self-contained system containing amplifiers, precision-frequency power supplies, and blower, provides selective or simultaneous erase for its 14 analog, f-m or pdm record/reproduce channels. It is fully compatible with the type 5-752 reel recorder (right) and together they form an integrated magnetic-tape system. **Circle 215 on Reader Service Card.**

Power Supply transistorized

LAMBDA ELECTRONICS CORP., 11-11 131 St., College Point 56, N. Y. A new all-transistor power supply with



One design engineer tells another exactly how he puts the "high" in "fidelity"

New design! Just demonstrated the model! FM's superb... such quieting... rock-stable tuning! Can't hear any hum in the wide-open audio preamplifier... or noise in the treble! And the power amplifier... *just feel that bass!* He has good reason to be proud. From front end to output stage, the design's a honey. And, as he says: *"...the tubes are RCA!"*

RCA tubes for monophonic and stereophonic high fidelity have been especially designed to bring out the best in your equipment. Among these are four special types—RCA-6973 and 7027 beam power tubes, RCA-7025, a high-mu twin triode controlled for hum and noise and the 7199, a remarkable triode-pentode combination.

Your RCA Field Representative will be glad to help you select the right tube for your circuit. Call him now. Or you can get technical data from RCA Commercial Engineering, Section D-19-DE2, Harrison, N. J.

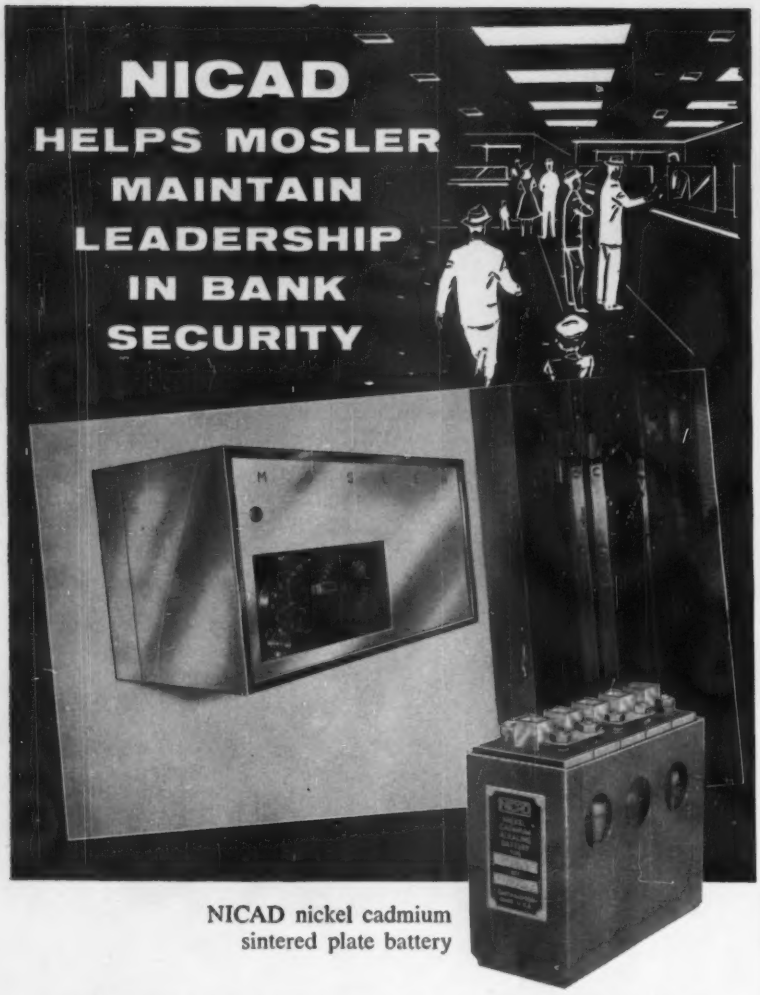
RCA Field Offices

EAST:
744 Broad Street
Newark 2, N. J.
HUmboldt 5-3900

MIDWEST:
Suite 1154
Merchandise Mart Plaza
Chicago 54, Ill.
WHitehall 4-2900

WEST:
6355 E. Washington Blvd.
Los Angeles 22, Calif.
RAymond 3-8361

RADIO CORPORATION OF AMERICA
Electron Tube Division — *Harrison, N. J.*



NICAD nickel cadmium sintered plate battery

With a reputation for providing top security, The Mosler Safe Company must be certain that its Century Bank Alarm system will perform reliably *under any conditions.*

A NICAD nickel cadmium battery makes such performance a certainty. Should the main power source fail, the NICAD battery provides vital stand by power.

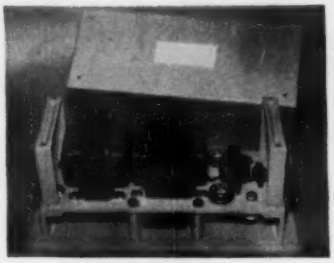
NICAD sintered plate batteries were chosen by Mosler on the basis of proved dependability and long-term service—a combination through which NICAD offers long-range economy. Additionally, NICAD offers cycle life which far exceeds that of any other battery . . . peak operational efficiency under severe conditions . . . low internal resistance that creates high discharge rates . . . capacity range from ½ to over 150 ampere hours.

For more information on the adaptability of NICAD batteries to signal alarm systems, air and space craft, microwave and telemetering devices, and similar equipment, request Bulletins 501 and 501A from NICAD Division, Gould-National Batteries, Inc., Easthampton, Mass.

NICAD TRADE MARK

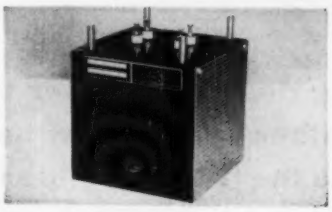
NICKEL CADMIUM
ALKALINE
STORAGE BATTERIES

a range of 0-1 ampere is being produced. It is convection cooled with no moving parts, no internal blowers. Voltage range is 0-32 v d-c. Unit is priced at $285 for the unmetered model (LT 1095) and $315 with meters (LT 1095 M). **Circle 216 on Reader Service Card.**



Servo Amplifier
solid-state

DI-AN CONTROLS, INC., 40 Leon St., Boston 15, Mass. Model AS-20 servo amplifier is specifically designed for use in critical heavy-industry and automation applications, in which long life and ability to withstand abnormal input or output stresses are important. Using semiconductor circuitry throughout, the unit is mechanically and electrically ruggedized. For example, a unique input circuit will operate unharmed with continuous input overvoltage of 2,500 percent. **Circle 217 on Reader Service Card.**



Power Supplies
plug-in type

CONSOLIDATED AVIONICS CORP., Westbury, L. I., N. Y. New a-c/d-c plug-in power supplies are available with regulated and unregulated outputs. Reliable performance under elevated temperature conditions is assured as a result of the larger heat sink provided through housing each unit in a finned aluminum case. Units are available to operate from

A HOFFMAN SEMICONDUCTOR APPLICATION CASE HISTORY

Over 9,500 hours ago, the successful Vanguard Satellite was launched. We salute the U. S. Navy and its cooperating agencies, as the Satellite, launched over a year ago, continues in orbit.

THIS POWER RELIABILITY PROBLEM HAD TO BE SOLVED

FOR SPACE VEHICLES

Hoffman Silicon Solar Cells were the solution

The transmitter of the U.S. Navy's Vanguard Satellite required an extremely reliable power source with the highest possible light energy conversion efficiency. Hoffman Silicon Solar Cells were chosen to do this exacting job. To date a new record has been set for continuous electrical power in outer space (with no "time-out" for refueling).

If you require a highly dependable electrical power supply, with a wide operating and storage temperature range of from −65°C to +175°C, a higher light conversion efficiency (up to 10%), an extended spectral response range of from 4,000-11,500 angstroms, benefit from Hoffman's unequaled experience as the pioneer in the commercial development of Silicon Solar Cells and their uses.

For details consult the Hoffman Solar Cell applications specialist in your immediate area or write to Department SS.

If you need a job in electronics done quicker and better, contact

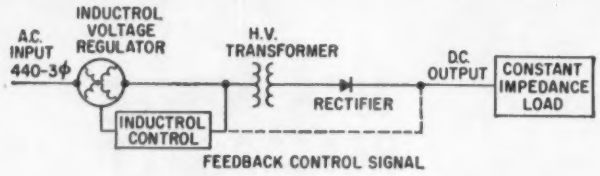
Hoffman Electronics H
CORPORATION
SEMICONDUCTOR DIVISION
930 PITNER AVENUE EVANSTON, ILLINOIS

GENERAL ELECTRIC VOLTAGE REGULATION IDEA FILE

By C. A. NEUMANN

FOR RADAR ENGINEERS

Using General Electric Inductrol* Regulators in the high-voltage power supply of radar systems



Because the high-voltage power supply is an inherent part of the transmitter portion of a radar system, there is much concern over keeping the system effectively and continuously operative despite voltage control problems.

The diagram above illustrates how General Electric Inductrol regulators help solve this problem.

With the regulator in the circuit, as shown, it is possible to regulate the power supply output voltage while combining both the run-up function and the precise voltage control function.

ANY DESIRED RANGE OF VOLTAGE CONTROL for the system can be incorporated into this single regulator. In addition, the Inductrol voltage regulator, through its associated controls, corrects for input voltage variations and fluctuations of the load, while compensating for regulation of the circuit and changing characteristics of the rectifier element.

For reliable operation of the high-voltage power supply, the Inductrol regulator must provide the desired range of d-c power required. Problems such as line voltage variation, load changes, infinite d-c level requirements, being able to withstand high fault currents, and system regulation must be accomplished reliably and automatically for continuous operation of the power supply.

AS AN EXAMPLE, *here is a typical high-voltage power supply with the following requirements: d-c voltage—18 kv max., d-c current—1.7 amps max. Line voltage variation ±10%, d-c output voltage to be adjustable from 2 kv to 18 kv. System characteristics are: power factor—90%; efficiency—95%, system regulation—10%.*

TO OBTAIN VOLTAGES OF 2–18 KV with your three-phase bridge rectifier, the Inductrol regulator will vary the 440 V, three-phase input on the transformer primary in direct proportion to the H.V. requirements. In addition, it will automatically compensate for line voltage variations, load changes, and system regulation while being able to withstand fault currents of 25 times normal (for 2 seconds) and giving infinite voltage adjustment from 2 to 18 kv. This is accomplished without having the control device introduce waveform distortion, is free from contact maintenance (no brushes or switch contacts) and maintains ±1% accuracy over the full range. Inherently, the Inductrol regulator, whether dry-type or liquid-filled design, is virtually free from maintenance requirements.

OTHER INDUCTROL REGULATOR USES: Line voltage correction (60 or 400 cycle) control of filament power supplies, focus coil control, and grid voltage control in radar systems, variable speed antenna drives, computers, and many other electronic equipments.

FOR MORE INFORMATION, write to Section 425-20, General Electric Company, Schenectady 5, New York.

*Registered Trademark of the General Electric Company for Induction Voltage Regulators.

Progress Is Our Most Important Product

GENERAL ELECTRIC

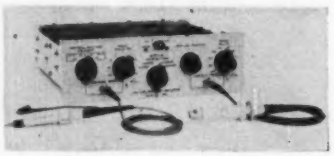
110 v, 60 or 400 cps input with outputs of 6, 12, 24, 75, 150, 250, and 300 v d-c, and with currents up to 400 ma. **Circle 218 on Reader Service Card.**

Phototube ten-stage, head-on

RADIO CORP., OF AMERICA, Harrison, N. J., has introduced type 7326, a ten-stage, head-on type of multiplier phototube. It is designed for use in applications such as flying-spot scanning and photometry which require low dark current as well as high sensitivity over the entire visible spectrum. The tube is also very useful in scintillation counter applications. **Circle 219 on Reader Service Card.**

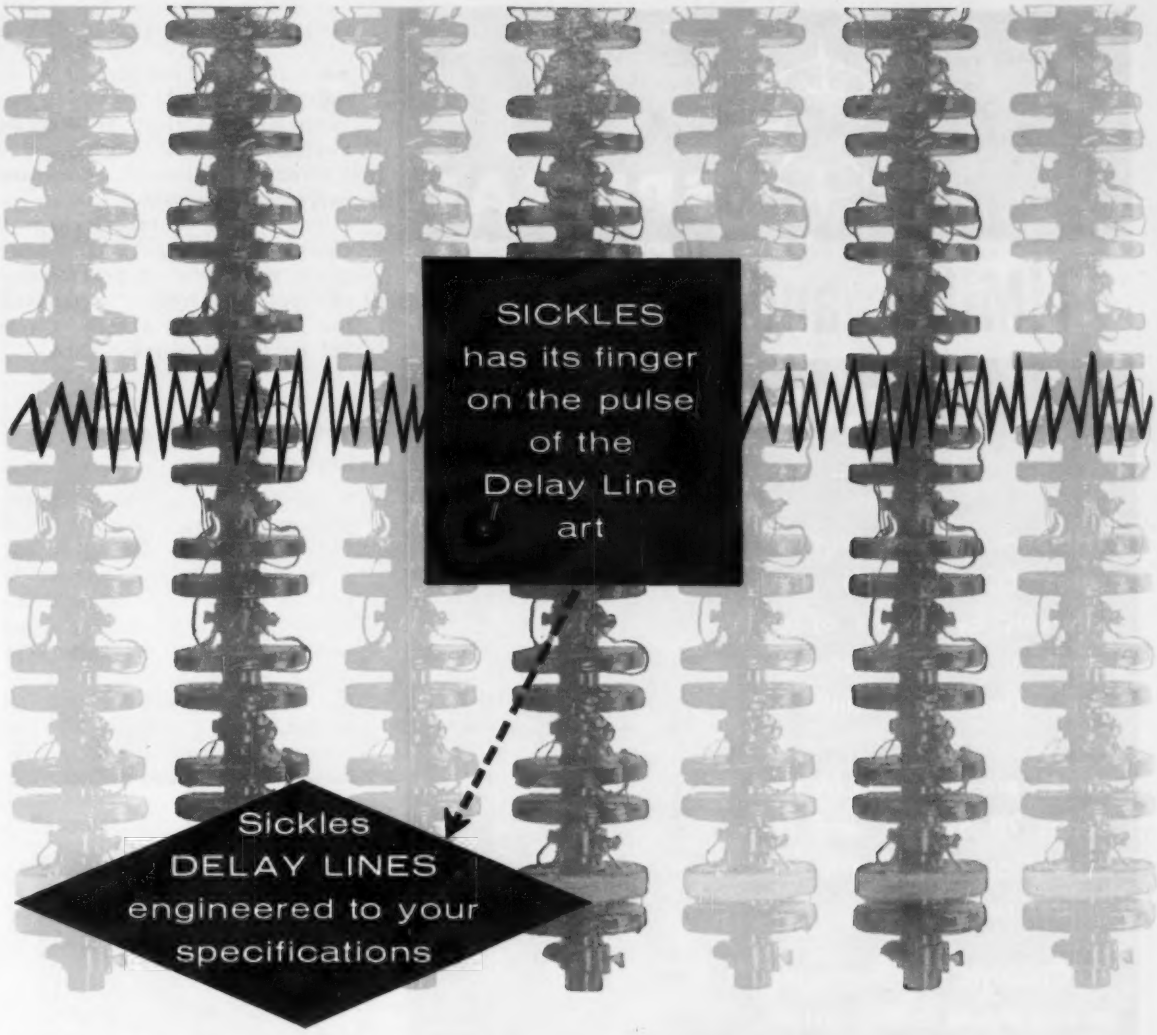
Ten-Turn Pots subminiature

DAYSTROM PACIFIC, 9320 Lincoln Blvd., Los Angeles 45, Calif., has available ten-turn pots only ½ in. by 1 in. in size. They incorporate V guides and spring-loaded rods that eliminate backlash and insure stability. Double wipers, one on either side of the resistance element, eliminate intermittents caused by shock and vibration, and double the effective resolution. **Circle 220 on Reader Service Card.**



Amplifier voltage/current

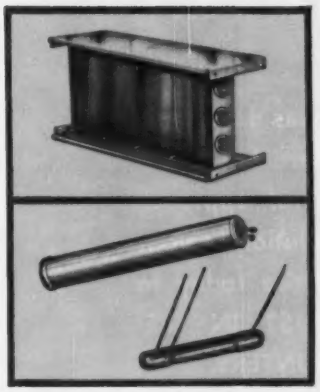
HEWLETT-PACKARD CO., 275 Page Mill Road, Palo Alto, Calif. Designed for use with the model 150A oscilloscope, the model 154A voltage/current dual channel amplifier provides simultaneous measurement and observation of both



The complexities of delay line design and manufacture hold no fears for Sickles. We've built up a 38 year record of success in precision coil winding – and *since 1938* have produced delay lines for a host of applications including color TV, commercial air controls, computers, missiles and military guidance systems.

No matter how complex the job, our engineering laboratory can contribute. If quantity production is required, of course Sickles as one of the world's largest coil producers can handle that too – bringing into play our complete (and in many instances, *unique*) facilities for volume manufacture.

We'll be glad to discuss your delay line problem – and have a qualified representative call on you. For information, write direct to Section SI-4.



At upper left is a typical composite of 5 delay lines, hermetically sealed in a metal case which we have produced for ground-to-air traffic control. Its major lumped line has Td = 20.3 usec tapped at each 1.45 usec with a rise time of 0.5 usec.

Distributed lines, at lower left, can be supplied with time delays up to 25 usec with impedances of 300 to 5000 ohms. They may be hermetically sealed, potted, resin dipped or encapsulated.

F. W. SICKLES DIVISION/*General Instrument Corporation*
Leaders in electronic coil winding and assembly since 1921
165 Front Street (P. O. Box 330) Chicopee, Mass.
Other plants in Joliet, Ill. and Waterloo, Ont., Canada

DIAMOND WEAVE SICKLES QUALITY APPARATUS

GENERAL INSTRUMENT CORPORATION INCLUDES F. W. SICKLES DIVISION, AUTOMATIC MANUFACTURING DIVISION, RADIO RECEPTOR COMPANY, INC. AND MICAMOLD ELECTRONICS MANUFACTURING CORPORATION (SUBSIDIARIES)

SPECIAL

TIMING and COUNTING

INSTRUMENTS

THE Series 70 System measures CONTINUOUS time intervals by means of an electronic memory or storage. Time increments as well as continuous time intervals are measured by the Series 70 System, and recorded on tape punch and printer readout.

ELECTRONIC time averaging of two inputs to this system averages out errors due to eccentricities.

THIS System was developed for testing inertial gyros — but the general approach may be the solution to your problems! Write today to the SPECIALIST IN FREQUENCY COUNTERS.

NORTHEASTERN ENGINEERING, INC.
MANCHESTER, N. H. • 25 So. Bedford St.
P. O. Box 150 • NAtional 2-6485

a-c voltage and a-c current waveforms. Electronic switching between channels, either by alternate sweeps or by 100 kc chopping, allows a direct comparison of voltage and current relationships within a circuit. The current channel, equipped with a current sensing probe, provides direct presentation of current waveforms by clamping the probe around a wire. **Circle 221 on Reader Service Card.**

VHF Preamplifier
low noise

HALLER, RAYMOND, AND BROWN, INC., Science Park, State College, Pa. Model 53ONS broadband vhf preamplifier has a gain of 42 db from 50 to 300 mc. Average noise figure is less than 8 db. Packaged weight is 4 lb without power supply. Power input is 70 w. Other models have bandwidths from 50 to 250 mc and cover frequency range from 50 to 500 mc. **Circle 222 on Reader Service Card.**

D-C Supplies
extremely rugged

SORENSEN & CO., INC., Richards Ave., South Norwalk, Conn., has developed the model MD heavy duty d-c supplies. They consist of conservatively rated magnetic-type voltage regulators, full-wave silicon diode rectifiers, and capacitive input filters. Units can be supplied from stock with output voltages ranging from 2.5 to 1,000 v d-c, with power capacities of 25, 50, 100, 200, 400, 750, 1,500 and 3,000 w. **Circle 223 on Reader Service Card.**

Panoramic Receiver
joystick control

CGS LABORATORIES, Route 7 at 35, Ridgefield, Conn., announces an

Meet Bill Bushor and Sam Weber

Associate Editors, **electronics**

FEATURE ARTICLE EXPERTS

Resumés:

Bushor, William E., Lawrence Institute of Technology, BSEE, I. R. E. member. 9 years experience: U.S. Army (communications chief), Bell Aircraft (air-to-air missile), G. M. Research Labs, Sperry Gyroscope, etc. Member Society Technical Writers.

Weber, Samuel, Virginia Polytechnic Institute, BSEE, I. R. E. member. 10 years diverse engineering experience: U. S. Navy, Barlow Electrical Mfg. Co., Curtiss-Wright, etc. Primarily in communications, uhf and microwave components and design, jet engine test instrumentation.

Present Occupations:

Bill Bushor is preparing a series to appear in 1959 on medical electronics comprising diagnostics, therapeutics, prosthetics, and clinical and operative aids.

Sam Weber is working on "Sophisticated Communications Methods" for the October 1959 issue. Report covers scatter systems, meteorburst transmission, satellite relays, carrier systems, etc.

References:

If you're not a subscriber, if your subscription is expiring, if you will miss exciting features "in-the-works" by **electronics** 26-man staff, fill in box on Reader Service Card. Easy to use. Postage free.

ABC ABP **electronics**

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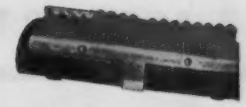
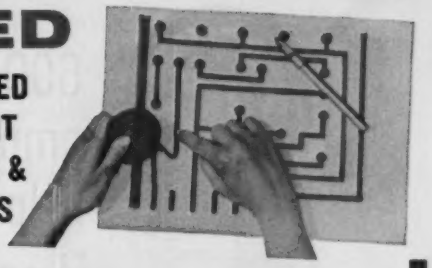
NEW!

"SEE-THRU"

RED

PRINTED CIRCUIT TAPES & SHAPES





ELIMINATE MOST NEGATIVE RETOUCHING — CUT DRAFTING TIME. New Brady "See-Thru" Red self-sticking tapes and shapes speed production, increase accuracy in laying out printed circuit layouts. Translucent — easy to register on lines. Photographs opaque black. Thin plastic film (.002") assures sharp, clean outlines. Close tolerance pre-cut self-sticking shapes are non-smudging. Matching connector strips in rolls. Over 100 standard shapes and sizes in stock for immediate delivery. **Write for new Bulletin and FREE TEST SAMPLES.**

Manufacturers of Quality Pressure-Sensitive Tape Products — Est. 1914

W. H. BRADY CO.

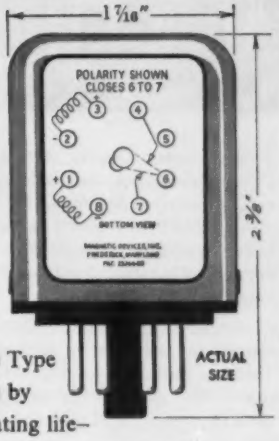
735 W. Glendale Ave., Milwaukee 9, Wis.

93A

CIRCLE 78 READERS SERVICE CARD

MDI **POLARIZED RELAYS**

COMPACT
RUGGED
HIGH SPEED
LONG LIFE
TESTED and PROVEN



High speed, sensitive Type 300 Polarized Relays by MDI give long operating life—tested and proven by years of military use.

Coil Resistance 25 to 4,000 ohms

Operating Current 2 to 60 MA

Overall Dimensions 1-7/16" x 1-7/16" x 2-3/8"

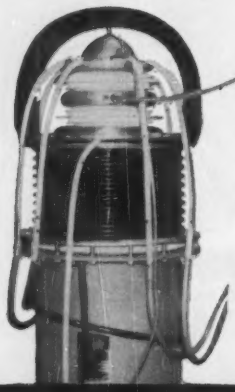
For full details, write, wire or phone today

MAGNETIC DEVICES, INC.

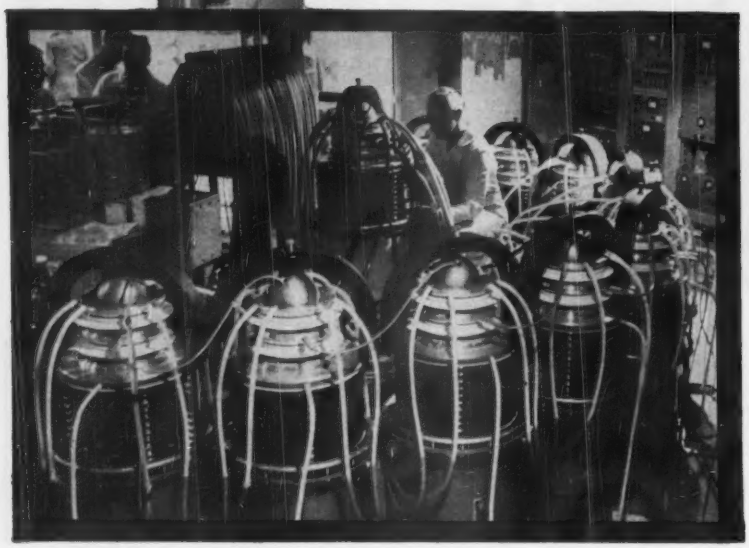
Dept. E, 712 East Street • Frederick, Md.

CIRCLE 125 READERS SERVICE CARD

LOOK TO TOBE FOR PROGRESS



600,000 amperes help harness H-power



At the recent Geneva Atoms-For-Peace Conference, Los Alamos scientists unveiled *Scylla*—a fusion device used to heat a plasma of ionized heavy hydrogen particles millions of degrees by blasting it with a 600,000-ampere thunderbolt.

Surrounding the heart of this thermonuclear machine is a bank of Tobe low-inductance, energy-storage capacitors...*each* rated at 100,000 volts *each* capable of a 20,000 megawatt peak surge.

Why *Tobe* capacitors? Because only Tobe, with over 30 years of capacitor manufacturing experience, could meet the rigid design specifications set for the project. Tobe can meet yours too. So, whether you need a bank of thermonuclear energy-storage capacitors or a miniaturized tubular, talk to Tobe. Our engineers speak your language.

For further technical information or engineering aid, write Tobe-Deutschmann Corp. Norwood, Mass.

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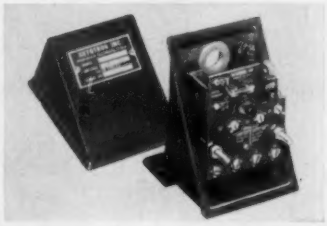
electronically tuned panoramic receiver with new joystick control. Vertical motion of the joystick controls the amount of expansion of the crt display; horizontal, the centering of the display. This TRAK receiver operates over the 100 to 150 mc range. Bandwidth is 30 kc; noise figure, 9 db at the worst point. With a dynamic range in excess of 60 db, sensitivity is 0.5 μv, and spurious responses are 60 db or more down. **Circle 224 on Reader Service Card.**



Photoelectric Control transistorized

AUTOTRON, INC., 3629 N. Vermilion, Danville, Ill. Conservative operating requirements of the new model BT1 transistorized photoelectric control are 10 ft-candles minimum light with 0.04 sec minimum dark time and 0.04 sec minimum light time. The control relay energizes when light is on the sensing element. Contacts are spdt, silver cadmium oxide, rated 8 amperes at 115 v a-c, noninductive load. **Circle 225 on Reader Service Card.**

Test Chamber automatic operation

THE AMERICAN RESEARCH CORP., Farmington, Conn. A new vibration test chamber, which has a temperature range of −100 F to +350 F with mechanical refrigeration, is

How far can an engineer go at AC?

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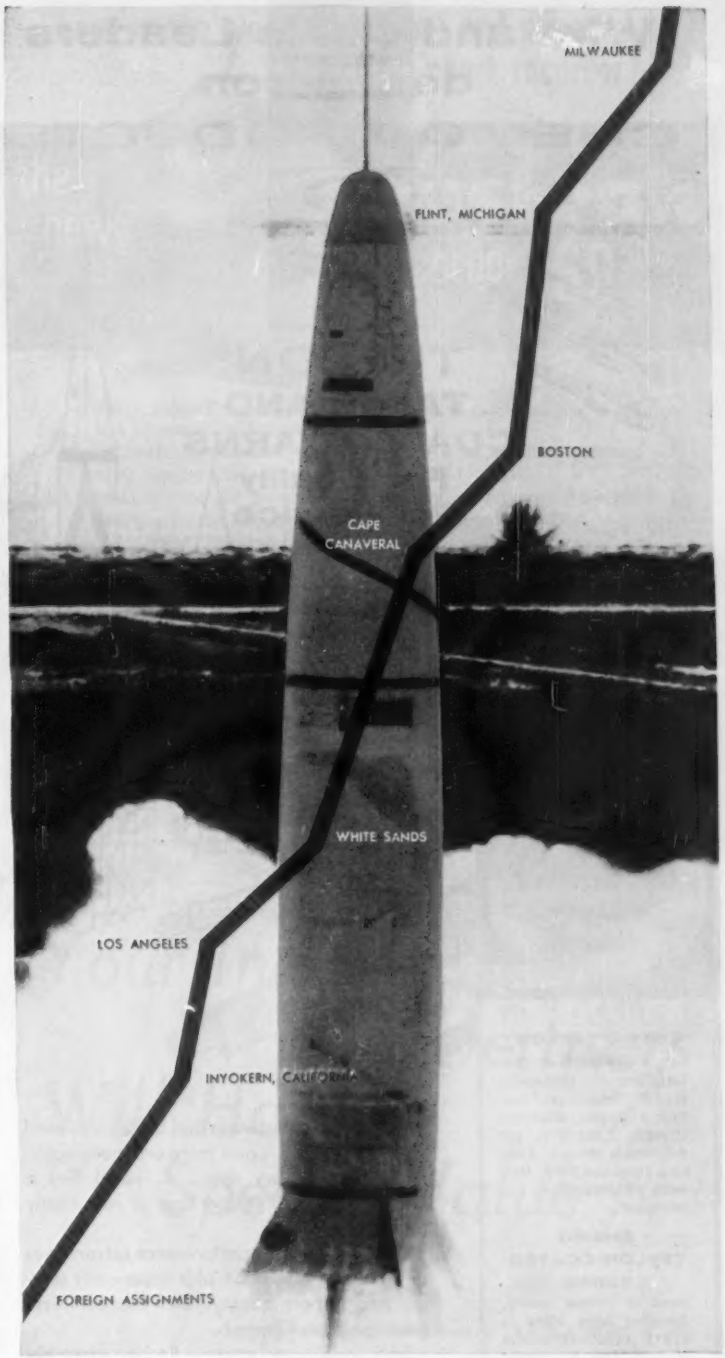

The Thor, launched on a cushion of flames, is guided by the AChiever. And the AChiever does its job so well that the demand for AC products is constantly increasing.

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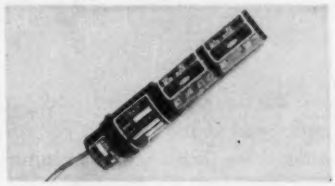
NEW YORK OFFICE: 1071 AVENUE OF THE AMERICAS

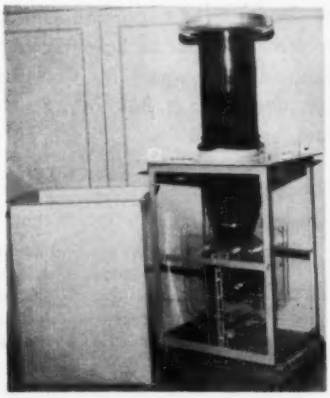
62-9

furnished with a removable insulated plug and a flexible diaphragm. Testing may be done with the vibration table in a horizontal or vertical position. Chamber has a free test space of 4 by 4 by 4 ft. **Circle 226 on Reader Service Card.**



In-Line Sub-System space-saving

THOMAS A. EDISON INDUSTRIES, McGraw-Edison Co., 61 Alden St., West Orange, N. J., announces a new space-saving in-line sub-system consisting of a size 10 servo motor, a gear head containing a clutch, and two precision potentiometers. Many different in-line modular units are available to the systems engineer containing any component adaptable to rotary operation such as resolvers, potentiometers, synchros and tachometer-generators. **Circle 227 on Reader Service Card.**



H-V Transformer corona-free

DEL ELECTRONICS CORP., 521 Homestead Ave., Mt. Vernon, N. Y. New corona-free h-v transformers intended for research purposes are rated at 200,000 peak volts at 10 ma. Their design and construction employ modern techniques and ma-

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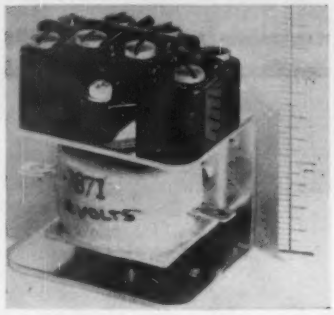
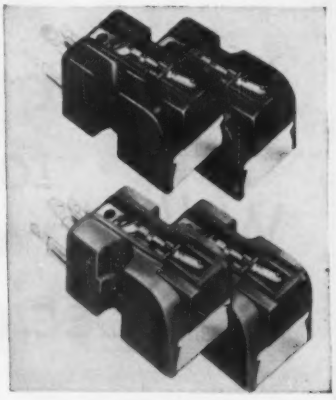
terials including mylar and special epoxies for insulation purposes. **Circle 228 on Reader Service Card.**



Power Relay heavy duty

ACRO DIVISION, Robertshaw-Fulton Controls Co., Columbus 16, Ohio. Outstanding feature of a new power relay is its ability to carry an extremely heavy load. The switch has UL approval for a rating of 20 amperes, 2 h-p at 230 v a-c. Largest dimension of the relay is less than 3 in.; length is 2 1/16 in., and width about 1½ in. **Circle 229 on Reader Service Card.**



Stereo Cartridge four versions

CBS-HYTRON, Danvers, Mass., announces the Columbia constant displacement stereo cartridge in four versions. The basic twin-ceramic cartridge can be purchased with either a diamond or sapphire stylus and in either the in-phase of out-of-phase connection. In-phase cartridges provide conventional phasing of the output signals for each channel. This permits use of the

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advancement in instrument design

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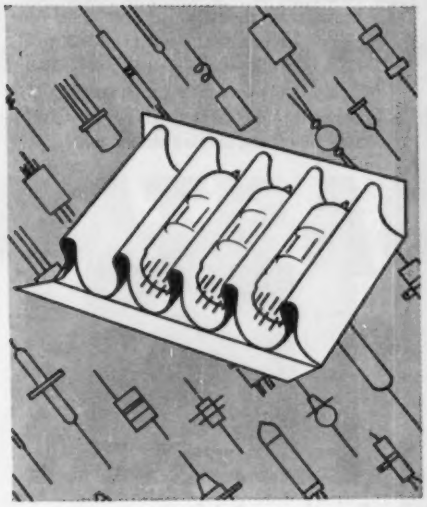

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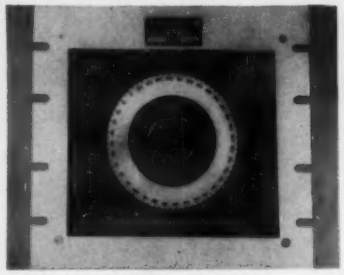
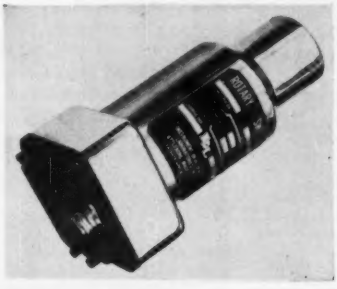
cartridge with either stereo or monaural records in any dual-amplifier or conventional stereo amplifier system—or it can be used in monaural systems by connecting the cartridge outputs in parallel. **Circle 230 on Reader Service Card.**



Resolver Bridge precision unit

JULIE RESEARCH LABORATORIES, INC., 556 W. 168th St., New York 32, N. Y., has available models PSB-5 and PRB ultraprecision bridges which permit checking synchros or resolvers to an accuracy of 0.002 percent every 5 deg of angular position. These precision standards feature symmetric construction and maintain rated accuracy over 0-4,000 cps, and have been used successfully at somewhat reduced accuracies up to 10 kc. **Circle 231 on Reader Service Card.**



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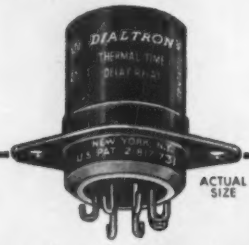

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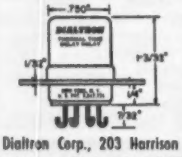

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ter pulse which can be externally interconnected to provide either a pulse of 2 live segments and 3 dead segments or 3 live segments and 4 dead segments. **Circle 232 on Reader Service Card.**

Servo Assembly aluminum casting

DATRAN ELECTRONICS, 1836 Rosecrans Ave., Manhattan Beach, Calif., offers a new servo assembly for use by designers of automatic null balance systems. It includes a Holtzer-Cabot 4 pole 60 cycle servo motor, drive coupling, shaft, bearings and gear drive assembly, digital counters with automatic shutter action to indicate plus or minus digital output, and one or more balance or output potentiometers. **Circle 233 on Reader Service Card.**

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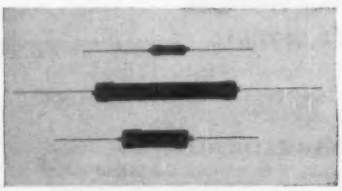
FALSTROM CO., 44 Falstrom Court, Passaic, N. J. The standardized FT-192 rack cabinet is designed for a wide variety of uses with or without accessories. It is designed and engineered to permit easy modifications at little additional cost. Unit is of formed construction, and designed to make possible the use of heavier loads and afford stable anchoring points for components and chassis. **Circle 234 on Reader Service Card.**



Carbon Film Resistor long load life

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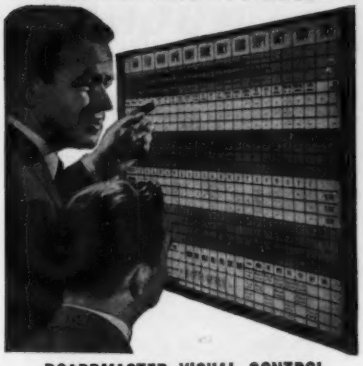

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MODEL 1040

SPECIFICATIONS

Frequencies.....400 or 1000 C.P.S. by selector switch (other frequencies on request)
Distortion.....Less than 1%
Hum Level.....Approximately .05% of rated output
Output Power...3 watts into matched resistive load
Power Supply...115 volts, 60 C.P.S., 40 watts
Dimensions.....5-11/16 x 9 x 6⅛ inches

OTHER MODELS AVAILABLE

MODEL	DESCRIPTION	POWER OUTPUT
1040A	Sim. to Mod. 1040	8 watts

EXCELLENT ACCURACY AND STABILITY • TRANSFORMER ISOLATED OUTPUT • 3 OUTPUT IMPEDANCES • LOW INTERNAL IMPEDANCE • OUTPUT VARIABLE UP TO 120 VOLTS

MODEL 1500

SPECIFICATIONS

FREQUENCY.....400 CPS (Other freq avail.)
Distortion.....Less than ½ %
Hum Level.....Approximately .02%
Output Power....20 watts
Power Supply....115 volts, 60 CP.S.
Dimension.....8¾" x 19" x 8" deep

OTHER MODELS AVAILABLE

MODEL	DESCRIPTION	POWER OUTPUT
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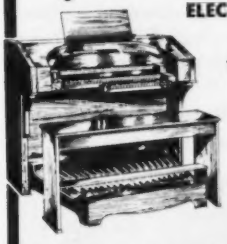

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FIRST 920 Channel Single Conversion VHF Mobile Receiver Uses HYCON EASTERN CRYSTAL FILTER

VHF, 920 Channels, fully transistorized Radio Receiver by Avco Mfg. Corp., Crosley Division

Hycon Eastern 11.5 Mc Crystal Filters Measure 2" x 1½" x ¾"

Bandwidth at 6 db attenuation: 33 Kc

Bandwidth at 60 db attenuation: 60 Kc

Insertion Loss: 4 db

Ultimate attenuation: 80 db

Mobile communications for today's fast moving military operations require equipment which is rugged, compact, highly accurate and dependable. Filling this need is the Avco-Crosley, fully transistorized, 920 channel, mobile VHF-FM Radio Receiver incorporating a Hycon Eastern 11.5 Mc Crystal Filter and matching Discriminator.

The use of only one frequency conversion provides excellent image rejection in combination with high adjacent channel selectivity. By eliminating multiple conversions, cross modulation and receiver desensitization are reduced even in the the presence of strong interference from any of the other 920 channels.

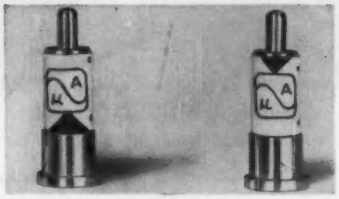
High Frequency Crystal Filters for mobile applications offer the advantages of small size, freedom from microphonic behavior, and ability to maintain their characteristics throughout the entire temperature range of −60°C to +90°C. Hermetically sealed, no realignment or readjustment is ever required.

There are Hycon Eastern Crystal Filters designed to solve selectivity problems in AM or FM receivers and SSB transmitters, whether fixed or mobile. Hycon Eastern engineers can assist you in choosing filter characteristics best suited to your needs. Write for Crystal Filter Bulletin.

HYCON EASTERN, INC.

75 Cambridge Parkway Dept. A Cambridge 42, Mass.

far greater resistance to heat and moisture than a composition resistor. It is also available in much closer tolerances, has a longer load life and far better temperature coefficient. It was specifically designed for use in computers, commercial instruments and similar applications. **Circle 235 on Reader Service Card.**



Silicon Diode as high as 60 kmc

MICROWAVE ASSOCIATES, INC., Burlington, Mass. The Varactor is a diffused silicon p-n junction diode designed to be a variable capacitance with low loss at high frequencies. Unit complies with MIL-E-1 outline 7-1 for cartridge type crystal rectifiers and will fit most standard crystal holders. In the standard MA-460 series, the pin end of the diode is connected to P-type material on the top of a small "mesa" and the N side of the silicon element is connected to the base. The reversed polarity unit denoted by the suffix R is also available. **Circle 236 on Reader Service Card.**

Power Inverter transistorized

ARNOLD MAGNETICS CORP., 4613 W. Jefferson Blvd., Los Angeles 16, Calif. A new transistorized power inverter supplies a-c sine-wave power from a battery line source. Unit is especially designed to insure maximum performance from a-c gyros and motors. No excess heat is created because the output waveshape, being sinusoidal, avoids the

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Do you know that many cancers can be cured if detected early? That an annual health checkup is your best protection against cancer?

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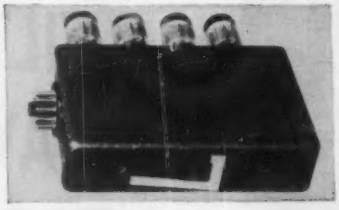
heat-producing harmonic currents which are characteristic of square-wave operation. There is no loss of efficiency due to sine-wave operation because the transistors are operated as saturated switching elements. **Circle 237 on Reader Service Card.**

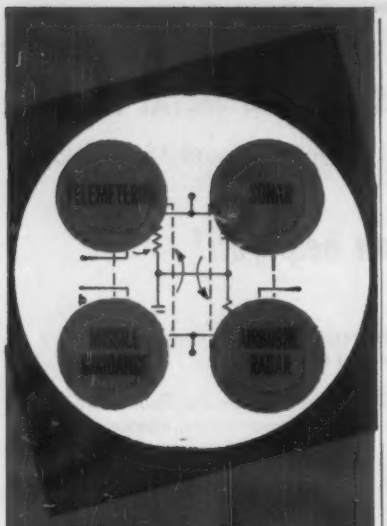
Servo Motor size 8 unit

INDUCTION MOTORS CORP., 570 Main St., Westbury, N. Y., announces a new size 8 servo motor designed for transistorized applications in aircraft and missiles. The BT705-1 features a high torque to inertia ratio over an unusually short length. The control phase is designed with a high-impedance center-tapped winding for transistor use. **Circle 238 on Reader Service Card.**



Counting Unit in-line display

BECKMAN INSTRUMENTS, INC., 2200 Wright Ave., Richmond 3, Calif. A new type of decimal counting unit features a single-digit display, 1¼ in. high, packaged as an integral part of the plug-in counting module. A large in-line display can be created simply by mounting several units side-by-side. Digits are formed by selectively illuminating from 5 to 11 character segments. All digits lie in the same surface plane so that the display can be read throughout a 150 deg viewing angle. Maximum counting rates of 100 kc and 1 mc are available. **Circle 239 on Reader Service Card.**



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NEW INSTRUMENT LOAD for TYPE N

Provides excellent stability... plus low reflection

AMCI TYPE 1108B SHOWN FULL SIZE

- A nearly reflectionless termination for 50-ohm coaxial transmission lines over the frequency range of 0 to 1100mc.
- Suitable as a secondary standard.
- VSWR under 1.02.
- Rated maximum input power: 0.5 watt.
- Designed around a metal-film-on-glass type of resistor.
- Other connector types available on request.

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SAVE SPACE AND WEIGHT!

	Miniature Series	Sub-Miniature Series
Cross Section	1 7/16" x 1 31/32"	31/32" x 1 3/16"
Length	2 1/4" long	2" long
Weight	6 ounces	3 ounces
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High Temperature: 125°C (250°F)
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Contact arrangements up to 4 pole double throw.
Unique transistorized R.C. time constant network.
Time Delays from 50 MS to 120 seconds. Longer Delays available.
Hermetically sealed housings.

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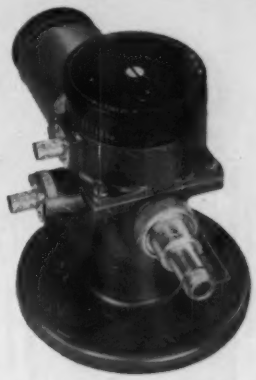
SOMETHING NEW IN SLOTTED SECTIONS



Actually, this is a new kind of Standing Wave Detector, which completely makes obsolete the 8-foot monsters, for impedance and VSWR measurements from 100 to 1000 mc/s.

The PRD Type 219 is only 8 inches long and weighs a "pocketable" four and one-half pounds.

As if these facts were not startling enough, the 219 also features:

- Direct reading of VSWR
- Direct reading of angle of reflection coefficient
- Direct reading of reactive component sign
- Matched load for self-calibration supplied
- Adaptability to most coaxial lines, including the LT and new TNC series
- Low cost
- Rugged construction

Listed below are a few of the important specifications.

Frequency Range:	100 to 1000 mc/s
Residual VSWR:	Less than 1.03
Minimum Input Signal:	Approx. 1V at 100 mc/s; 0.1V at 1000 mc/s for measuring a matched load
Characteristic Impedance:	50 ohms
Detector:	Crystal included
RF Input Connector:	BNC jack
RF Output Connector:	Type N jack supplied. Connector types available include types C, BNC, LT, TNC, 7/8" coax.
Audio Output Connector:	BNC jack
Dimensions:	8" L x 5" W x 5 3/4" H
Weight:	4 1/2 pounds

f.o.b. Brooklyn, New York

Note to owners of the new PRD Catalog, E-8: Don't bother reading this ad. All these details and more can be found on page B-13. If you are unfortunate enough not to own a copy of this designers' workbook, send your request on your company letterhead please.

If all you want are specifications on the 219, fill out the inquiry card in this magazine.

POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC.
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Magnetically latched SPDT, with two independent coils, Series P Relays are available with various coil resistances from 10 to 4,000 ohms each coil. Contact ratings will vary with switching speeds desired, but range from 60 milliamperes to 2 amperes.

Extremely compact, to save space and weight, they fit standard octal sockets. Their impact and vibration resistance is excellent for relays of this type, thanks to extra-rugged construction.

"Diamond H" engineers are prepared to work out a variation to meet your specific requirements. Write or phone us your needs.

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Phone Jackson 5-3491

Literature of

MATERIALS

Mica Isolators. Magnetic Shield Division Perfection Mica Co., 1322 No. Elston Ave., Chicago 22, Ill. An 8-page data sheet K-5 covers mica isolators for transistor heat sink applications. **Circle 250 on Reader Service Card.**

Kovar Alloy. The Carborundum Co., Perth Amboy, N. J. Those concerned with making pressure and vacuum-tight seals with hard glasses will find useful the information contained in a recent booklet on Kovar alloy. **Circle 251 on Reader Service Card.**

COMPONENTS

Lacing Cords. Alpha Wire Corp., 200 Varick St., New York 14, N. Y. An illustrated 4-page brochure covers the 76 synthetic lacing cords and tapes carried in inventory. **Circle 252 on Reader Service Card.**

Tantalum Capacitors. Fansteel Metallurgical Corp., North Chicago, Ill. A 16-page technical booklet on what to expect from tantalum capacitors of the wet electrolytic type has just been released. **Circle 253 on Reader Service Card.**

Potentiometers. Waters Mfg., Inc., Wayland, Mass. Folder PF1258 covers the complete line of standard precision pots and includes many pots for special applications. **Circle 254 on Reader Service Card.**

EQUIPMENT

Galvanometer. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa. A two-page data sheet ED2(1) describes the type E guarded d-c galvanometer. **Circle 255 on Reader Service Card.**

Laboratory Test Instruments. Freed Transformer Co., Inc., 1724 Weirfield St., Brooklyn 27, N. Y., has available the No. 558 fully il-

the Week

lustrated catalog of precision laboratory test instruments. **Circle 256 on Reader Service Card.**

Function Generator. Navigation Computer Corp., 1621 Snyder Ave., Philadelphia 45, Pa., is offering a new 12-page report describing a digital controlled function generator. **Circle 257 on Reader Service Card.**

D-C Voltmeter. Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif. Vol. 10, No. 5 of the *Journal* covers a new digital d-c voltmeter with automatic range and polarity selection. **Circle 258 on Reader Service Card.**

Trace Blanker. Photographic Instrumentation Development Co., 19458 Ventura Blvd., Tarzana, Calif. A well-illustrated bulletin describes the features and operation of a trace blanker which adds greater versatility to recording oscillographs. **Circle 259 on Reader Service Card.**

Magnetic Shift Registers. C K Components, Inc., 101 Morse St., Watertown, Mass. An 8-page brochure deals with the theory of magnetic shift registers and contains detailed information on the company's standard line of units. **Circle 260 on Reader Service Card.**

UHR Standard Bridge. Mideastern Electronics, Inc., 32 Commerce St., Springfield, N. J. A catalog sheet completely describes model 801 uhr standard bridge for precise measurement of resistance from 1,000 ohms to 110 million megohms. **Circle 261 on Reader Service Card.**

FACILITIES

Electrical Contacts. Contacts Inc., 1100 Silas Deane Highway, Wethersfield, Conn., has available a catalog describing its products and the services it has to offer in the selection of the most effective contact material for any specific application. **Circle 262 on Reader Service Card.**

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Characteristics and performance range of existing units:

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operating altitudes: from 10,000 ft. to 50,000 ft.

weights: from 8 lbs. to 115 lbs. complete

Smaller packs feature replaceable chemical dehydrator elements – the larger subsystems are available with automatic reactivating dehydrators.

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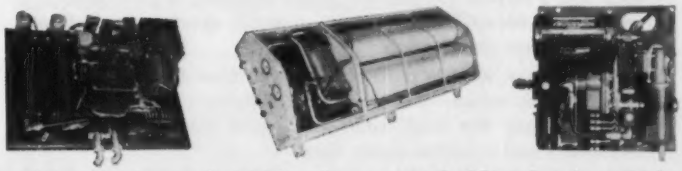
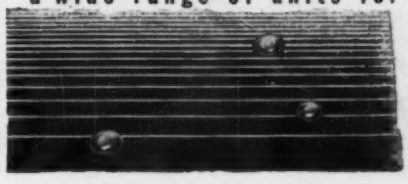


a wide range of units for specialized air control



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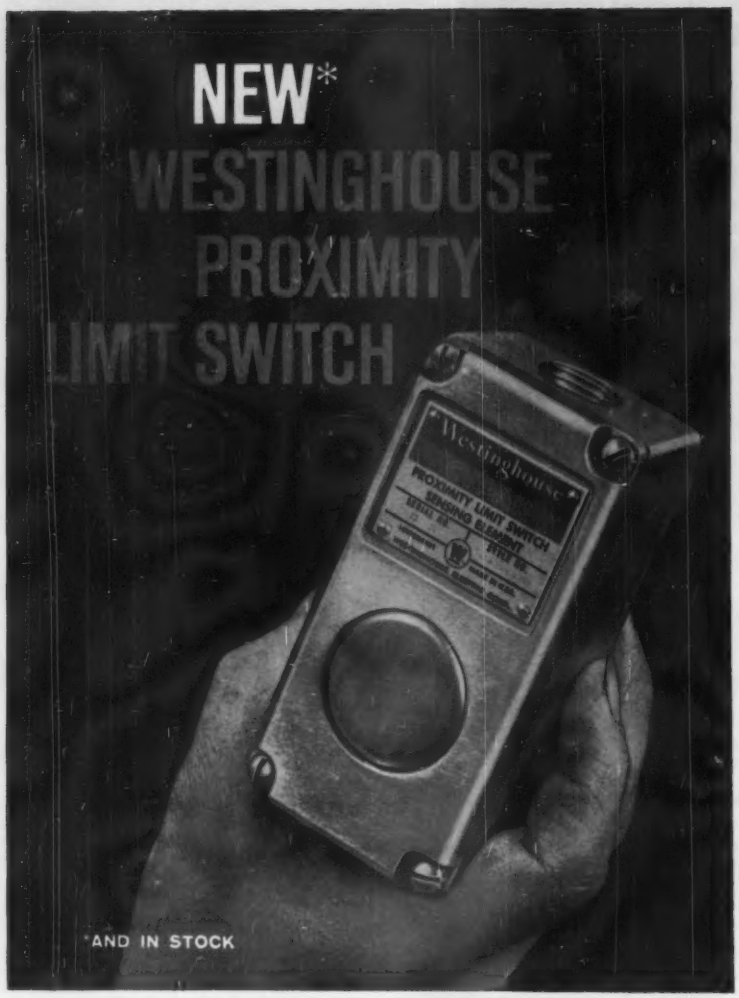

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NEW BOOKS

Principles and Applications of Random Noise Theory

By JULIUS S. BENDAT

John Wiley & Sons, Inc., New York, 1958, 431 *p*, $11.00.

UNTIL two years ago, the literature on Noise Theory was unfortunately confined to research papers published in the technical journals. There then appeared three texts: "Random Processes in Automatic Control" by Laning and Battin (McGraw-Hill 1956), "Principles of Noise" by Freeman (Wiley 1958) and "Random Signals and Noise" by Davenport and Root (McGraw-Hill 1958). With the addition of the book by Bendat to this list, the previous paucity of text material has now perhaps become a plethora. Bendat's book must be reviewed, accordingly, not in isolation, but vis-a-vis the aforementioned texts.

Comparative Merit—In general, Bendat's book suffers greatly by such a comparison. Where the material of this book overlaps directly that of its predecessors (and this is a nonnegligible fraction of the text), its exposition appears less lucid and its attention to important detail less meticulous.

There are many, many carelessly worded statements throughout the book (on p 5 one learns that every stationary process is nonstationary, to give but one example) that will surely serve as stumbling points for the neophyte. The treatment of numerous topics that are replete with subtleties is heuristic in nature; while this is not always in itself a fault in a book intended as an engineer's introduction to a sophisticated subject, one should give ample warning that all is not really as simple as it may seem.

The book can serve well for the novice wishing to get a quick physically motivated overall picture of what noise theory deals with. For the serious student planning to work in this field, however, the previously mentioned texts, though sometimes more difficult, have many advantages.—DAVID SLEPIAN, *University of California, Berkeley, Calif.*

THUMBNAIL REVIEWS

Insulation Engineering Fundamentals. By G. L. Moses, R. Lee and R. Hillen, Lake Publishing Co., Lake Forest, Ill., 1958, 117 p, $2.75 (paper). Based on a series of articles from **Insulation**, this book covers uses, importance, achievements, weaknesses and problems of insulation. In addition to the basic chapters, the chapters on special electronic insulation, high and power frequency electronic equipment insulation should be of particular interest.

Analog Simulation. By W. J. Karplus, McGraw-Hill Book Co., Inc., New York, 1958, 434 p, $10.00. Devoted completely to solution of field problems by analog techniques, this book also presents the necessary mathematical tools.

Linear Programming. By R. O. Ferguson, McGraw-Hill Book Co., Inc., New York, 1958, 342 p, $10.00. Intended for people at all levels of management, this book shows how to use linear programming for solving certain types of management problems.

Concise Guide to Plastics. By H. R. Simonds, Reinhold Pub. Corp., New York, 1957, 318 p, $6.95. Basic practical data on strength properties, processes production and prices of almost all American commercial plastics are presented along with their selection, uses and forms. This guide should be of value to those who use plastics in any way in the electronics industry.

Introduction to the Design of Servomechanisms. By J. L. Bower and P. M. Schultheiss, John Wiley & Sons, Inc., New York, 1958, 510 p, $13.00. This book intends to answer the question: "Given the basic components of a servo system and a set of performance specifications, what should be the form of the complete loop-gain function?" After an introduction to stability and single and multiple-loop feedback system design, consideration is given to such factors as harmonic response, time response, error coefficients and noise response.

Sampled Data Control Systems. By J. R. Ragazzini and G. F. Franklin, McGraw-Hill Book Co., New York, 1958, 331 p, $9.50. Directed to practicing engineers and graduate students, this book presents a unified treatment of material found in papers, reports and recent research of the authors and their colleagues on the analysis and design of sampled-data feedback and control systems.

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***Partial listing of contents "Designing For Reliability" (May 29th Special Issue)**

Part One — What is reliability?

I. Definition: The probability that a device will perform its objective adequately for the period of time intended under the operating conditions encountered.

A. Measures of Adequacy. 1. For consumer products. 2. For commercial and industrial products. 3. For military products.

B. Reliability Levels. 1. In components. 2. In circuits. 3. In systems.

II. Means of Measuring.

A. Classical Statistical Measures.

B. Life Testing.

III. Effects of Environment and Service Conditions.

A. Environmental Data. 1. How environment affects performance. 2. Measuring environment. 3. Accumulation and interpretation of environmental data.

B. Servicing and Maintenance Conditions.

Part Two — How to achieve reliable designs.

I. Organization.

A. Planning. 1. Attitude and philosophy. 2. Working group.

B. Inspection procedures.

II. System Design.

A. Safety Margins. B. Monitoring, Metering and Warning Gear. C. Calculating System Reliability. D. Simplification of Systems. E. Package Design as Reliability Insurance.

III. Circuit Design.

A. Component Selection.

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2. ***Designing for Reliability — May 29th Special Issue**
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Tamar Accelerates Research

ACQUISITION of a 10,000-sq ft facility in Santa Monica, Calif., for expanded microwave-electronics research projects was recently announced by Tamar Electronics, Inc.

A microwave-electronic R&D and manufacturing corporation, Tamar is engaged in both military and commercial projects specializing in electronic countermeasure systems and components. Its chief hardware items include airborne transmission-line systems (scimitar antennas, adapters, connectors, umbilicals), transistorized radio remote control units, and microwave test equipment.

Tamar recently announced a 1958 gross military sales figure of $4½ million. Its most recent contract awards were received from the USAF, Boeing, Douglas, and Ramo-Wooldridge.

This latest addition to Tamar's existing facilities in West Los Angeles and Gardena, Calif., marks the firm's third such expansion-move in the past year.

Garbarino Joins Magnaflux

HAROLD L. GARBARINO recently joined Magnaflux Corp., Chicago, Ill., to fill the position of chief engineer-electronics. In this capacity he directs the department responsible for the development and improvement of eddy current nondestructive testing instruments, precision magnetic field measuring instruments, and ultrasonic thickness measuring equipment.

For the past seven years Garbarino has been with Armour Research Foundation, where he was assistant manager of electrical engineering research. Prior to that time he was development engineer for the General Electric Co.

Elect Officers for New Firm

THE board of directors of Silicon Transistor Corp., Carle Place, N. Y., recently elected Harold Sandler chairman of the board and appointed the following permanent officers: Robert L. Ashley, president; H. Sandler, treasurer; Donald Des Jardin, vice-president and secretary; and Randolph Bronson, vice-president.

The company, a newcomer in the industry, has begun production on silicon glass diodes and silicon power transistors. Firm's products will be aimed at the military electronics market.

IRC Appoints Chief Engineer

INTERNATIONAL RESISTANCE CO., Philadelphia, Pa., has appointed Larry McFarren to chief engineer of its Burlington, Iowa, plant.

Prior to joining IRC, McFarren was manager, resistor and dielectric assemblies engineering at General Electric Co., specialty electronic components department, Syracuse and Auburn, N. Y. He was previously associated with P. R. Mallory & Co., Inc., Indianapolis, Ind., as chief engineer, resistor division.

Servo Hires Statsinger

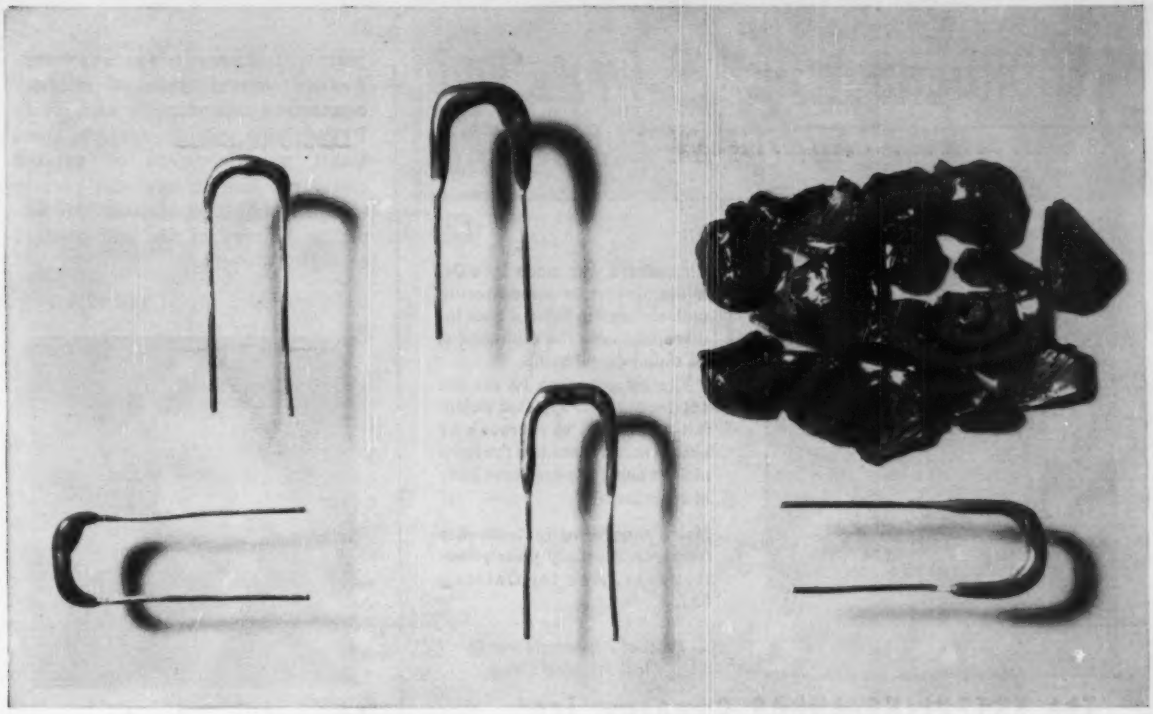
JOSEPH STATSINGER has joined Servo Corp. of America, New Hyde Park, L. I., N. Y., as director of engineering.

Prior to joining Servo, Statsinger was with the Arma Division of American Bosch Arma Corp. for 14 years. There, most recently, he served as assistant chief engineer in charge of missile guidance.

Elco Pacific Expands

NEW, larger quarters in West Los Angeles, Calif., were recently taken by Elco Pacific.

The move will provide the com-



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HIGH-PURITY LOW-MELTING GLASS

For Coating Electronic Devices

Here's good news for every producer of electronic devices. Low-melting glasses—a new research development reported before the Electrochemical Society by S. S. Flaschen and A. D. Pearson of Bell Telephone Laboratories* — may represent a major breakthrough in low cost and highly efficient protective coating of semiconductors, capacitors, diodes and other types of electronic devices.

These new, high-purity, low-melting glasses promise an ideal coating for protecting germanium and silicon transistors and diodes from atmospheric oxidation, contamination and humidity. Coating may be accomplished by simply dipping the devices in a fluid bath of the glass, withdrawing and cooling; by vapor deposition; or through the use of a pre-form (compressed powder).

Research quantities now available from B&A!

We can now supply low-melting glasses to meet the needs of your development engineers. Write us today for further information or technical assistance.

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*Abstract No. 116, Journal of The Electrochemical Society, August, 1958.

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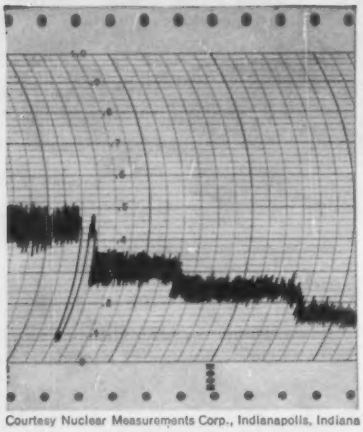
RECORDERS WORK... WHILE YOU ARE BUSY ELSEWHERE



Courtesy Nuclear Measurements Corp., Indianapolis, Indiana

This record was made by a DC Milliammeter in a monitoring unit, measuring fall-out over Indianapolis after the explosion of an experimental bomb.

The recorder was on the job continuously for 1½ days before fall-out began to increase as shown here. Meanwhile the technicians and engineers were busy at other tasks.

Make recording instruments help you multiply your effectiveness. Ask for Catalog 657.

Product Representatives in Most Principal Cities

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CIRCLE 164 READERS SERVICE CARD

This is not and is under no circumstances to be construed as an offer to sell, or as an offer to buy, or as a solicitation of an offer to buy, any of the securities herein mentioned. The offering is made only by the Prospectus.

New Issue March 26, 1959

40,000 Shares

General Transistor Corp.

Common Stock

Price $66.50 per share

Copies of the Prospectus may be obtained in any state only from such dealers participating in this issue, including the undersigned, as may legally offer these Securities under the securities laws of such State.

Kidder, Peabody & Co. — Hayden, Stone & Co.

Carl M. Loeb, Rhoades & Co. — Paine, Webber, Jackson & Curtis

Shields & Company — Francis I. duPont & Co.

E. F. Hutton & Company

pany with the needed space to manufacture several types of military connectors developed at Elco's Philadelphia plant; service West Coast manufacturers of printed circuitry; and to perform certain manufacturing operations to expedite delivery of the end product to region's users.

Mycalex Elects Board Member

DAVID R. HULL, vice president of Raytheon Mfg. Co., and currently serving as president of the Electronic Industries Association, has been elected to the board of directors of the Mycalex Corp. of America, Clifton, N. J.

Name Fredenburg Plant Manager

RAYMOND N. FREDENBURG was recently named plant manager for Mid-Eastern Electronics, Inc., Springfield, N. J., developers and manufacturers of electronic instruments and test equipment.

He was formerly with Weston

Electrical Instrument Corp. where he contributed to some of the early work in developing solid state electronic test equipment.

News of Reps

R. O. Whitesell & Associates is now the rep in the Kentucky-Indiana area for **Ungar Electric Tools, Inc.**, Los Angeles, soldering tool manufacturer.

Mid-Eastern Electronics, Inc., Springfield, N. J., appoints the **Kenneth W. Meyers Co.**, Park Ridge, Ill., for northern Illinois and southern Wisconsin; and the **J. L. Pierce Co.**, Detroit, Mich., for all of Michigan. Both of the sales organizations will handle Mid-Eastern's entire line of power supplies, special test equipment and ultra high resistance measuring instruments.

Deltron, Inc., Philadelphia, Pa., has named six additional reps to handle its power supply line. New reps and their territories are:

Lawrence F. Fuller, Jr., of Ardmore, Pa.—southern New Jersey, eastern Pennsylvania, Maryland, Virginia and District of Columbia.

Stanley K. Wallace Associates, Inc., of Lutz, Fla.—the southeast area.

Robert G. Moye Co., of Alhambra, Calif.—southern California to Fresno, southern Nevada and Arizona.

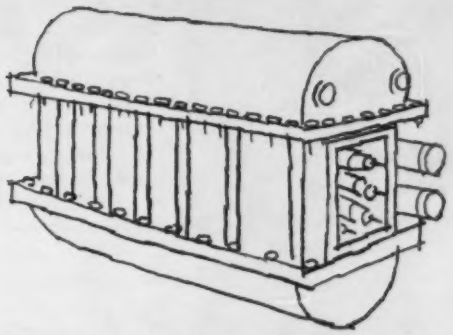
Carduner-Bosworth Co., of Port Washington, N. Y.—the New York metropolitan area.

Leo Jacobson Co., Inc., of Buffalo, N. Y.—upper New York State.

Northwest Sales & Eng. Service Co., of Seattle, Wash.—Oregon, Washington, Idaho, Montana, British Columbia, northern California south to and including Fresno.

Hunter & Salsbury Inc., Hicksville, N. Y., announce their appointment as reps for Industrial Transformer Co., Gouldsboro, Pa. They are covering the metropolitan New York-New Jersey territory for Industrial's line of commercial military and computer type transformers.

A PROBLEM OF UTMOST GRAVITY



RAYTHEON-DESIGNED, HIGH VOLTAGE DC MAGNETRON POWER SUPPLY

Weight, in one form or another, seems to be a concern of most of us today. While astronauts contend with the problem of "none at all", designers of electronic components continually face the problem of "too much".

An aircraft manufacturer recently called on Raytheon to design a 10,000-volt, 60-kva, 400-cycle, filtered DC magnetron power supply for high-temperature airborne-radar application. Several designs were available, but their weight -- more than 1,800 pounds -- put them in the lead balloon class.

Our engineers, thoroughly experienced in the field of fluorochemical transformer design, were able to get the "lead" out, about 1,300 pounds of it, and to come up with a unit (shown above) weighing less than 500 pounds.

Have any weighty problems? We'll be glad to lighten your load.

Simply write to:
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Excellence in Electronics

CIRCLE 166 READERS SERVICE CARD

what's happening in Tucson?

TUCSON IS FREE of the tensions and hustle of big cities. Tucson offers its residents a truly cultural atmosphere in a dry healthful climate with an average of 11 hours of sunshine every day.

The University of Arizona, with an enrollment over 15,000, functions as the center of cultural activities—offering a variety of orchestral, choral and dance programs. The fine Tucson Symphony plays regularly at the famed Temple of Music and Art.

The Fine Arts Show and Photo Workshop climax the year's activities in the visual arts with exhibitions and symposiums. Tucson's reputation is attracting many fine artists who make this their home. The Fashion Fiesta in February displays the latest work of the Southwest's top designers.

Spring Training activities of the Cleveland Indians...the Saturday Evening Forum (the nation's largest community forum)...the world famed rodeos and Spanish celebrations...these and more make Tucson a stimulating, rewarding place to live...and work.

(For more details see opposite page.)

COMMENT

Soft Magnets

We observed with interest your article "Soft Magnets for Amplifiers" (p 55, Feb. 6). We checked the magnetic characteristics of the alloys listed in this article and would like to comment on those shown for Hymu 80.

Currently, Hymu 80 is produced to an initial permeability at 40 gausses of 26,000 minimum. The average coercive force is 0.02-0.035 oersteds; residual flux density ranges from 2.5-5.0 kilogausses. The balance of data is correct. These magnetic characteristics are obtained after annealing in a dry hydrogen atmosphere at 2,050 F for four hours and furnace cooled.

A large variety of magnetic characteristics can be obtained from the 49-percent nickel alloy, and these depend upon melting techniques and methods of processing to produce the specified characteristics.

W. S. EBERLY
CARPENTER STEEL CO.
READING, PA.

Reader Eberly sent along several technical data sheets on Hymu 80, 400 and 800, and on other magnetic materials. We had given Hymu 80 an initial permeability of 10-20,000, an average coercive force of 0.05-0.07, and a residual flux density of 2.5. We were pleased to note how rapidly advances are being made in magnetic materials.

Microwave Hazards

(Re: "Researching Microwave Health Hazards," p 49, Feb. 20) I think you have done a good job in pulling together a large and diverse collection of information into a very readable and interesting article.

THOMAS S. ELY, M.D.
ATOMIC ENERGY COMMISSION
WASHINGTON, D. C.

. . . As you can well understand, the field concerned with the bio-

STANPAT SOLVES THE GHOSTING PROBLEM

NEW resin-base STANPAT ELIMINATES GHOSTING, offers better adhesion qualities on specific drafting papers!

THE PROBLEM
Some of our longtime customers first called our attention to the "ghosting" problem. Certain tracing papers contain an oil which could be leeched out by the STANPAT adhesive (green back) causing a ghost.

THE SOLUTION
A new STANPAT was developed (red back), utilizing a resin base which did not disturb the oils and eliminates the ghost. However, for many specific drafting papers where there is no ghosting problem, the original (green back) STANPAT is still preferred.

WHICH ONE IS BEST FOR YOU?
Send samples of your drawing paper and we will help you specify. Remember, STANPAT is the remarkable tri-acetate pre-printed with your standard and repetitive blueprint items—designed to save you hundreds of hours of expensive drafting time.

SO SIMPLE TO USE

1. PEEL the tri-acetate adhesive from its backing.

2. PLACE the tri-acetate in position on the tracing.

3. PRESS into position, will not wrinkle or come off.

STANPAT CO.
WHITESTONE 57, N. Y. Dept. 102
Phone: FLushing 9-1693-1611

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☐ Enclosed are samples of the drafting paper(s) I use (identify manufacturer). Please specify whether Rubber Base or Resin Base STANPAT is most compatible with these samples.

☐ Send literature and samples of STANPAT.

☐ Please quote price on our enclosed sketches which we are considering to have pre-printed.

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CIRCLE 168 READERS SERVICE CARD

logical effects of microwaves is a sensitive subject, especially that phase regarding hazards. Yet any information in this realm needs judicious publicity. When any article appears, we workers in this rather small group are somewhat apprehensive that the picture will be distorted, either by magnification or depression of the accumulated knowledge and concepts. In my opinion, your article was excellent. The subject was well covered, organized, and judiciously presented. You accurately reported the prevailing majority opinions, although not in all cases my own opinion—but this is the way it should have been reported.

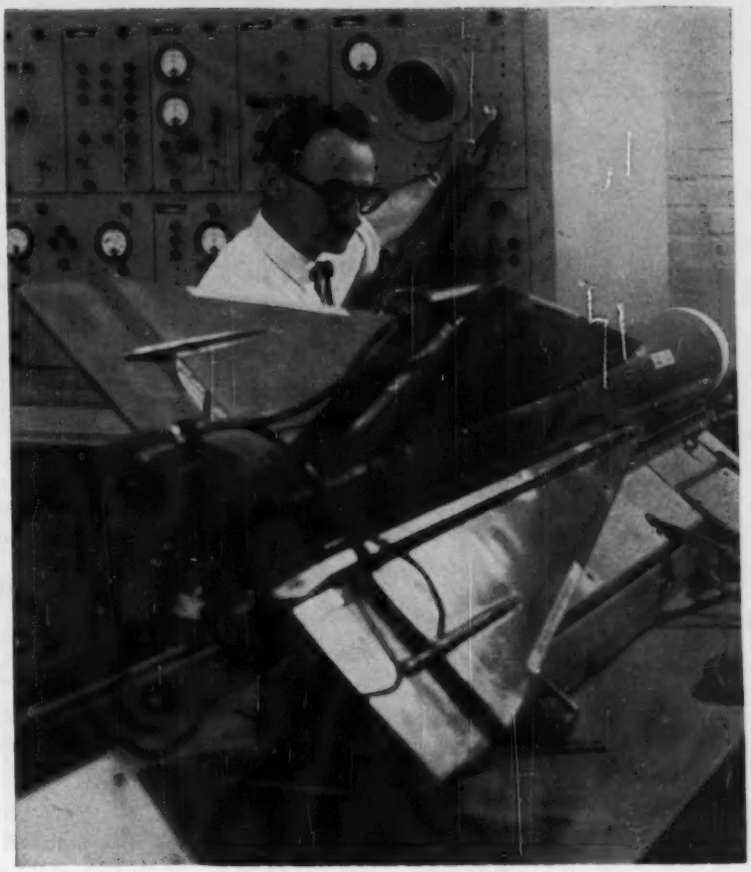
One technical criticism that I might suggest is that you did not clarify well the difference between quantitation and qualitation regarding the comparison of human problems and the smaller animal experimental results. A quantitative difference is widely agreed upon; few, if any, investigators have suggested that there is a qualitative difference.

Please do not misunderstand me; you did not say otherwise, but it seemed implied on p 49 regarding environmental temperature, and in the statement "not necessarily applicable." To repeat myself, the article was excellent, and the preceding remarks involve a minor point.

Your description of my dosimeter was an accurate summary of its characteristics, good and bad.

ALFRED W. RICHARDSON
ST. LOUIS UNIVERSITY
SCHOOL OF MEDICINE
ST. LOUIS, MO.

We are most interested in the idea that there is a qualitative difference between reactions of human beings and smaller furbearing animals to microwave radiation. Actually, our opinions lean toward agreement with researcher Richardson, but there was, at the time the article was prepared, no substantial documentation of the idea. It may be a minor point, but we feel strongly that all points of view in this matter of microwave health hazards deserve judicious hearing.



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GUIDED MISSILE DEVELOPMENT!

A HUGHES-TUCSON ENGINEER puts a new GAR 3 Falcon missile through its paces on the roller conveyor rails of an EGSP console.

With projects underway on new and highly advanced types of guided missiles, Hughes in Tucson offers assignments throughout the entire spectrum of missile research and development.

Hughes-Tucson offers permanent positions to people with the ability and enthusiasm to make major contributions in these areas: missile systems analysis, infrared and radar guidance systems, electromechanical and hydraulic control systems, missile test and handling equipment.

These opportunities for professional advancement are matched by the unique qualities of Tucson as a place to enjoy a fuller life. *(See the advertisement on opposite page.)*

Investigate Hughes...*and* Tucson... today. Send resume to Mr. James W. Kirchhoff at the address below.

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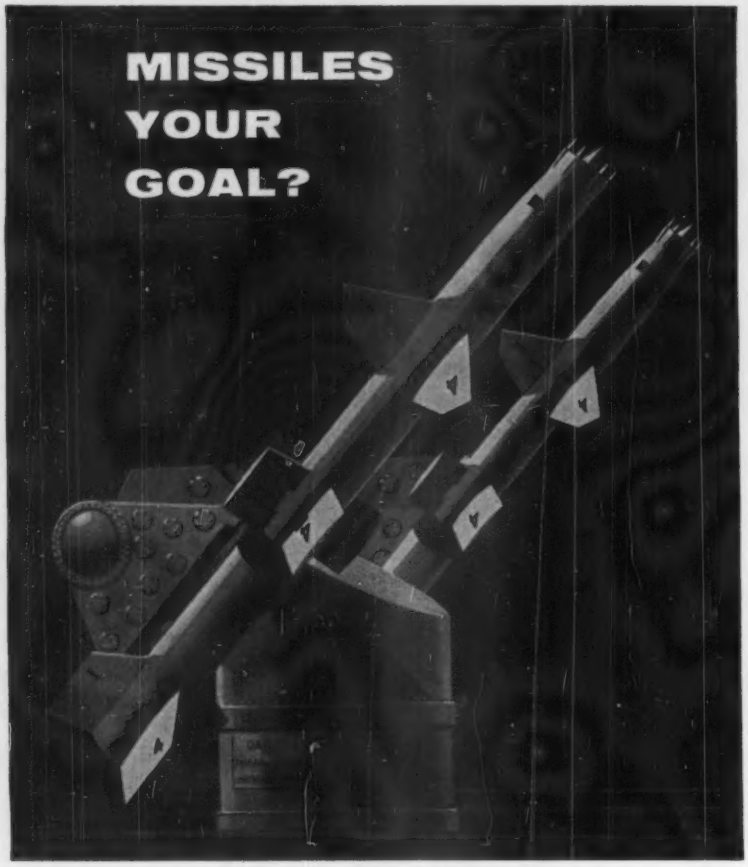

Get into a key missile program at BENDIX —prime contractor for the Talos missile

Engineering can be a really satisfying career—and within engineering one branch stands out. That's Guided Missiles. If the missile field is the one you want—hear this. We need engineers with exceptional ability who can handle responsibility.

At Bendix you work with men who are outstanding in every phase of engineering. You use facilities second to none. You do work that's challenging and important—work that offers exceptional opportunities to build your professional standing.

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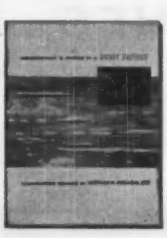
If this interests you and you want additional information, mail the coupon below for your copy of "Opportunities Abound at Bendix Missiles". You can read it through in half an hour—and it may prove to be the best half hour you've ever spent in your life.

Bendix PRODUCTS DIVISION Missiles



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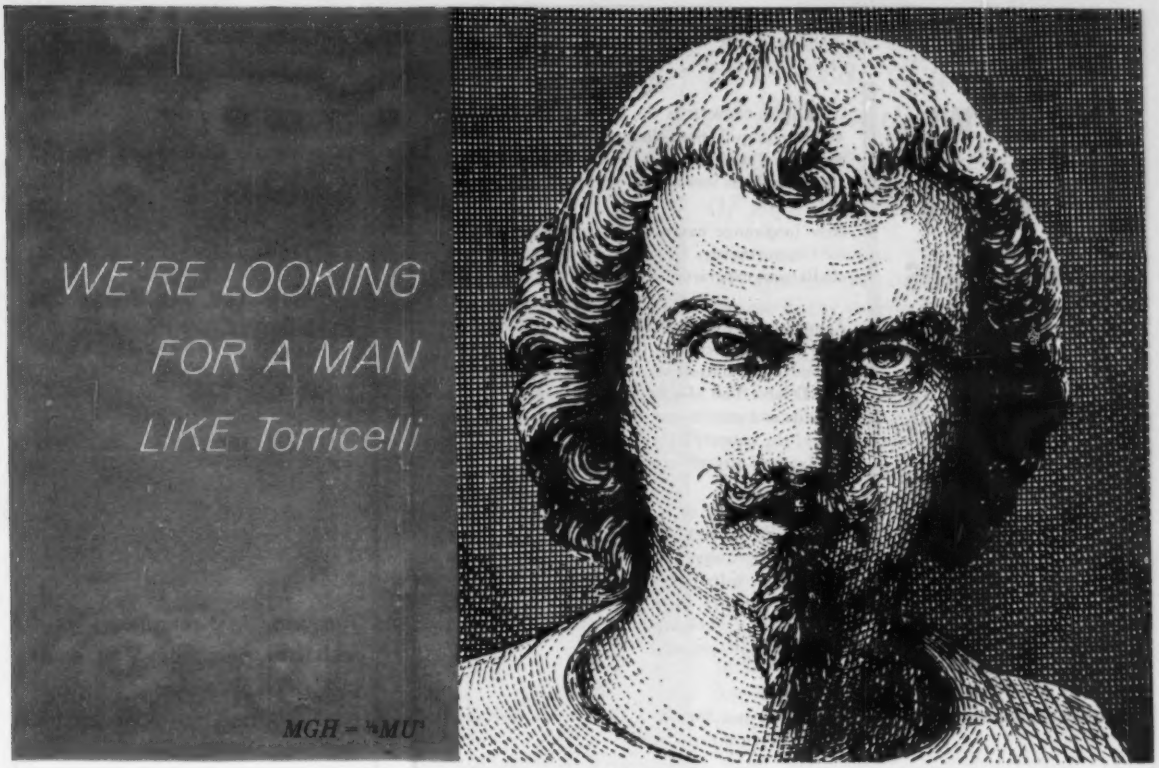

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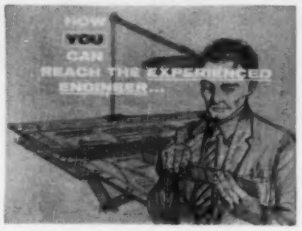

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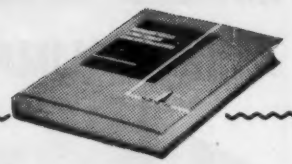

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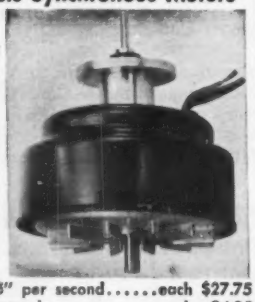

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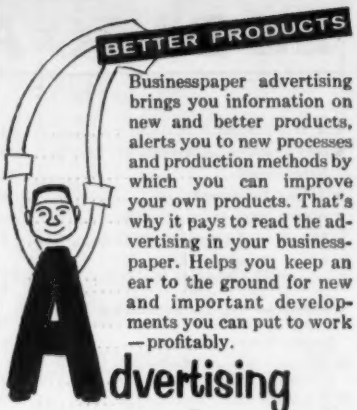

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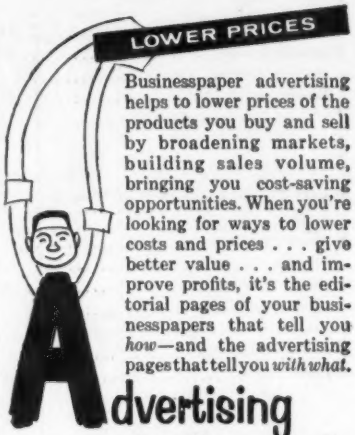

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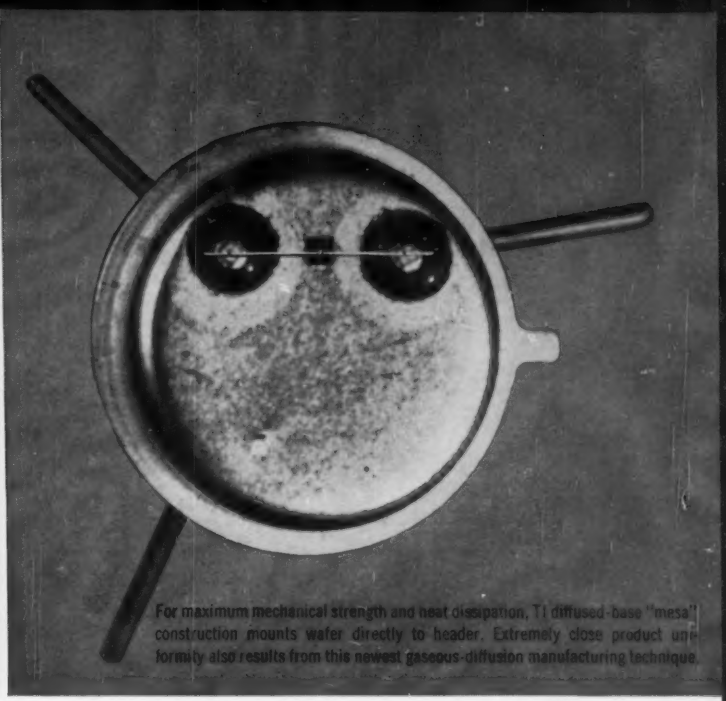
NEW TI HIGH FREQUENCY DIFFUSED-BASE GERMANIUM TRANSISTORS



For maximum mechanical strength and heat dissipation, TI diffused-base "mesa" construction mounts wafer directly to header. Extremely close product uniformity also results from this newest gaseous-diffusion manufacturing technique.

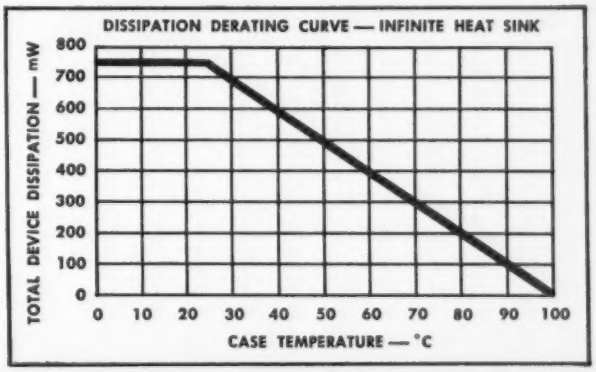
750 MC • 750 mW

ALPHA CUTOFF **MAX DISSIPATION**

Guaranteed current gains of 12, 10 and 8 db minimum at 100 mc with new TI 2N1141, 2N1142 and 2N1143 diffused-base germanium transistors! Alpha cutoff ratings up to 750 mc coupled with 750 mW power dissipation at 25°C case temperature make these newest TI transistors ideal for military high frequency power oscillators and amplifiers where assured reliability and performance are of primary importance.

All units are 100% production stabilized at temperatures well above their 100°C rated junction operating point . . . exceed MIL-T-19500A specifications . . . and are *in stock now.*

Contact your nearest TI sales office or nearby TI distributor *today* . . . for immediate delivery.



absolute maximum ratings @ 25°C case temperature

	2N1141	2N1142	2N1143	
Collector Voltage Referred to Base	−35	−30	−25	V
Emitter Voltage Referred to Base	−1	−0.7	−0.5	V
Collector Current	−100	−100	−100	mA
Emitter Current	100	100	100	mA
Device Dissipation (infinite heat sink)	750	750	750	mW
Collector Junction Temperature	+100	+100	+100	°C
Storage Temperature Range	−65 to +100			°C

typical characteristics @ 25°C case temperature

Frequency Cutoff (Common Base)	750	600	480	MC
Collector Reverse Current, $V_{CB} = -15V$, $I_E = 0$	1	1	1	μA
Saturation Voltage, $I_C = -70mA$, $I_B = 17.5mA$	2	2	2	V
Thermal Resistance Junction to Mounting Base	0.1	0.1	0.1	°C/mW
Small Signal Short Circuit Forward Current Transfer Ratio,	10 I_C	50 I_C	100 I_C	mA
$V_{CB} = -10V$, $f = 1000cps$	0.97	0.85	0.75	

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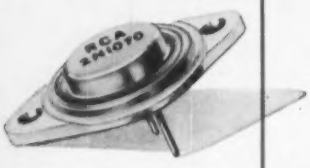
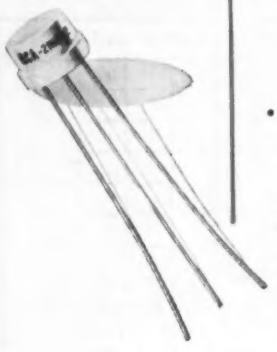


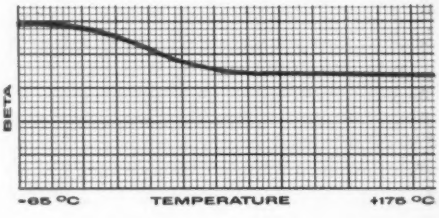


5 new RCA Silicon Transistors

DIFFUSED-JUNCTION MESA

...with excellent beta stability from −65°C to +175°C and exceptionally low saturation resistance!

- 2N1092—medium power
- 2N1067—intermediate power
- 2N1068—intermediate power
- 2N1069—high power
- 2N1070—high power



RCA's new n-p-n silicon transistors offer significant reductions in saturation resistance, and feature excellent beta stability over the entire operating temperature range. These features result from use of RCA's advanced diffused-junction mesa technique. These transistors are designed to meet stringent military environmental, mechanical, and life test requirements.

RCA silicon transistors offer the equipment designer a wide choice of power-switching capability in pr erred industry cases (JEDEC TO-3, TO-8, and TO-9).

RCA SILICON TRANSISTORS are commercially available in limited quantities. Your RCA Field Representative has complete information on these units and will be glad to discuss with you other silicon transistors now under development. For technical data on the 2N1092, 2N1067, 2N1068, 2N1069, and 2N1070, write RCA Commercial Engineering, Section D-19-NN2, Somerville, N. J.

Type	JEDEC Outline	ABSOLUTE-MAXIMUM RATINGS				CHARACTERISTICS								
						At Case Temperature of 25°C						At Case Temperature of 175°C		
						Saturation Resistance (ohms)			DC Current Gain (Beta)			DC Collector Cutoff Current (Icbo) (μa)		
		V_{CES}● (volts)	V_{CEO}▲ (volts)	Collector (amp.)	Transistor Dissip. ⁂ (watts)	Typical	Max.	Conditions	Typical	Min.	Conditions	Typical	Max.	Conditions
2N1092	TO-9	60	30	0.5	1	3	10	I_C=200 ma.	20	10	I_C=200 ma.	75	1000	V_{CBO}=30 volts
2N1067	TO-8●	60	30	0.5	2.5	3	10	I_C=200 ma.	35	15	I_C=200 ma.	75	1000	V_{CBO}=30 volts
2N1068	TO-8●	60	30	1.5	5	1	2.67	I_C=750 ma.	38	15	I_C=750 ma.	75	1000	V_{CBO}=30 volts
2N1069	TO-3	60	45	4	25	0.2	2	I_C=1.5 amp.	20	10	I_C=1.5 amp.	150	2000	V_{CBO}=30 volts
2N1070	TO-3	60	45	4	25	0.4	0.67	I_C=1.5 amp.	20	10	I_C=1.5 amp.	150	2000	V_{CBO}=30 volts

●"Heat-Sink" mounting clamp supplied.
●Collector-to-emitter breakdown voltage with base connected to emitter.
▲Collector-to-emitter breakdown voltage with base open.
⁂At a case temperature of 100°C.

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